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Valve Castings Made in Steel

Various Component Parts of Valves for Practically Every Purpose Beyond the Capacity of Cast Iron Are Poured From Steel Melted in an Electric Furnace

BY PAT DWYER

INCREASED use of steel castings in valves designed to control the flow of liquids or gases in high pressure lines prompted the Pittsburgh Valve, Foundry & Construction Co., Pittsburgh, to erect and equip a foundry a few years ago for this production. The building is on the company's property at 26th street and the Allegheny Valley railroad and rounds out the group of casting shops including the brass foundry where all the nonferrous parts are made, and the iron foundry described in the May 15, 1924 issue of THE FOUNDRY. The great bulk of the castings enter directly into the regular line of manufacture in which the company specializes, but when occasion warrants, a sufficient volume of miscellaneous outside jobbing work is taken to utilize the available capacity and absorb and distribute the burden of overhead expense.

The building is of steel frame construction with walls of corrugated galvanized steel sheets. It is lighted by numerous windows in the sides and on

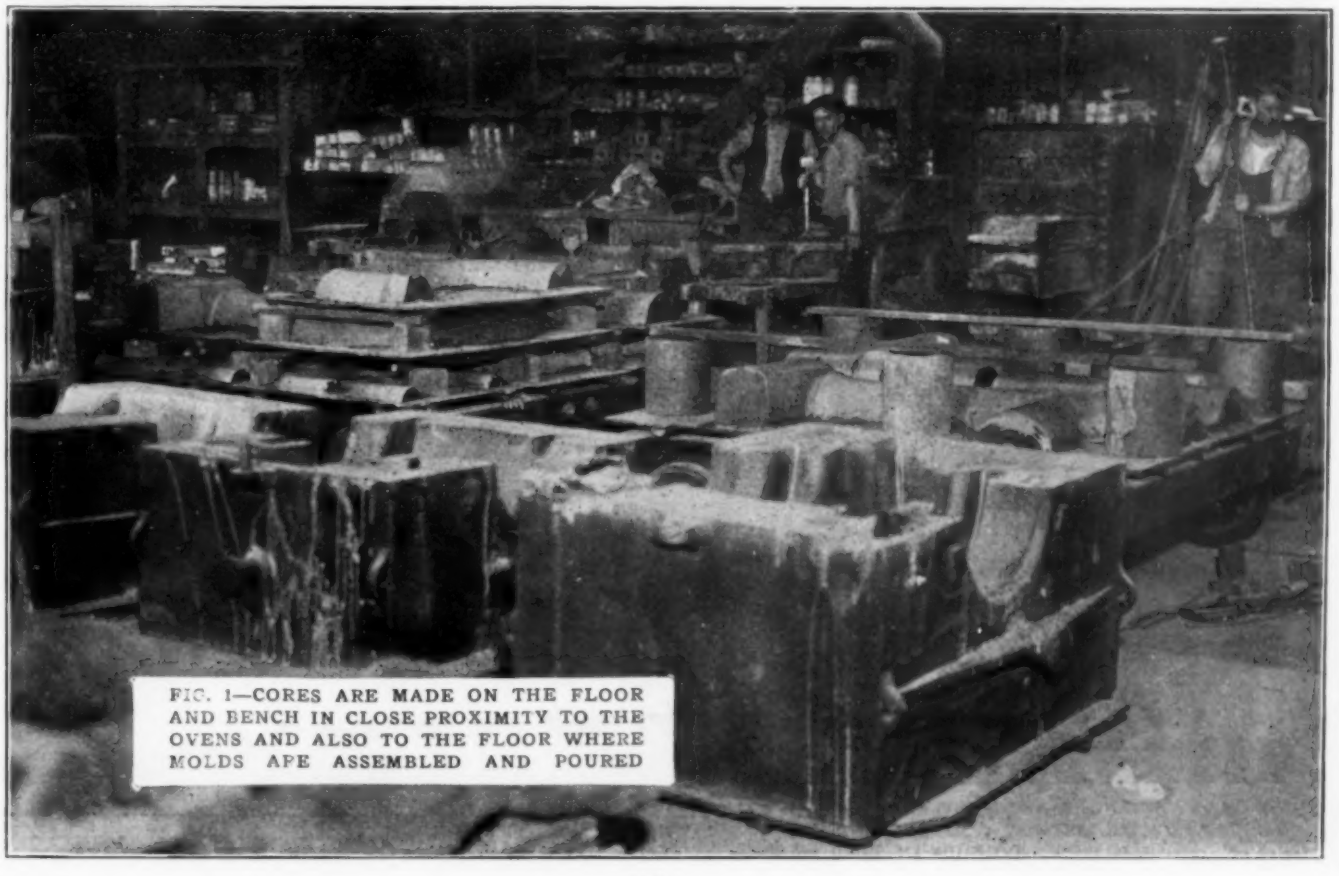

FIG. 1—CORES ARE MADE ON THE FLOOR AND BENCH IN CLOSE PROXIMITY TO THE OVENS AND ALSO TO THE FLOOR WHERE MOLDS ARE ASSEMBLED AND POURED

FIG. 2—AN INGENIOUS METHOD IS PROVIDED FOR FASTENING THE CORE LIFTING STRAPS BY A SINGLE RECTANGULAR STEEL LINK—IT IS JUST AS SAFE AS THE ORDINARY LACE OR BOLT BUT MAY BE APPLIED AND ADJUSTED MUCH MORE READILY—THE GATE STICKS SHOWN ARE PLACED IN THE LOOPS TEMPORARILY UNTIL THE CRANE IS READY TO PICK UP THE CORE

the roof. The floor space is laid off in a manner that will insure a steady forward movement of material in the regular sequence of operation. Thus, the molds are made near one end of the building, they are dried near the center,

FIG. 3—MANY FLANGES AND OTHER PLAIN FLAT CASTINGS ARE ASSEMBLED IN GROUPS HORIZONTALLY AND POURED AS A UNIT—THE METHOD ADOPTED FOR APPLYING THE GATE AND FEEDING HEAD ON A FLANGE DESIGNED TO BE POURED IN THIS MANNER IS SHOWN ON THE PATTERN BOARD AT THE LEFT

cored, set up and poured a little further along and cleaned at the opposite end of the building from which they started.

New silica sand is taken in through one end of the building and prepared for use on the floor and in the coreroom in a 6-foot pan mill made by the National Engineering Co., Chicago. Practically all the castings are destined for service on high pressure lines and for

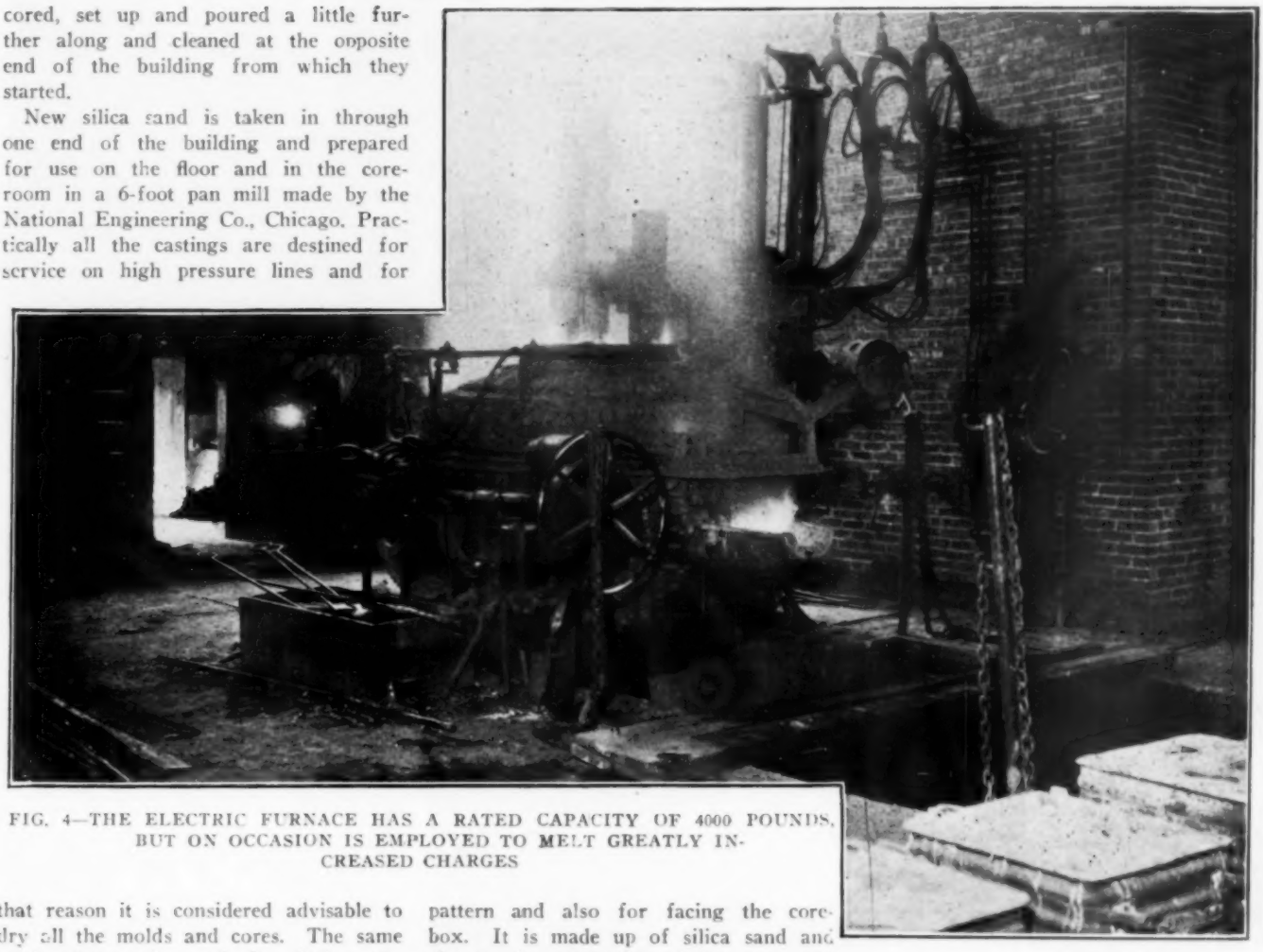

FIG. 4—THE ELECTRIC FURNACE HAS A RATED CAPACITY OF 4000 POUNDS, BUT ON OCCASION IS EMPLOYED TO MELT GREATLY INCREASED CHARGES

that reason it is considered advisable to dry all the molds and cores. The same sand mixture is used for facing the pattern and also for facing the corebox. It is made up of silica sand and clay in the proportion of 10 parts sand to 1 part clay. The mixture is wet with molasses water. The surface of the molds and cores is painted with a thin mixture of silica flour and molasses water before the molds and cores are placed in the ovens to dry. This treatment creates a hard, firm surface that does not yield to the weight or pressure of the molten steel.

FIG. 5—VALVE BODY MOLDS ARE MADE ON A JOLT ROLLOVER, PATTERN-DRAW MACHINE FROM A PATTERN SPLIT THROUGH THE CENTER AND ATTACHED TO A BOARD

Making the Molds

Assuming that the general layout of the floor is borne in mind it is apparent that the molds are made in that part of the foundry close to the sand supply. In addition to the new sand, all the sand from the flasks that have been poured, is taken back by the crane from the pouring floor and dumped in a pile in the center of the floor. An average of five heats a day are taken from the furnace and in that manner the sand dumping process is almost continuous. However, an adequate quantity of cold sand always is available and the hot sand is dumped in a position where it is given an opportunity to cool before it becomes necessary once more to shovel it into the flasks.

The large molds are rammed by hand on the floor in the usual manner and the smaller molds nearly all are made on several jolt-ram, rollover, pattern-

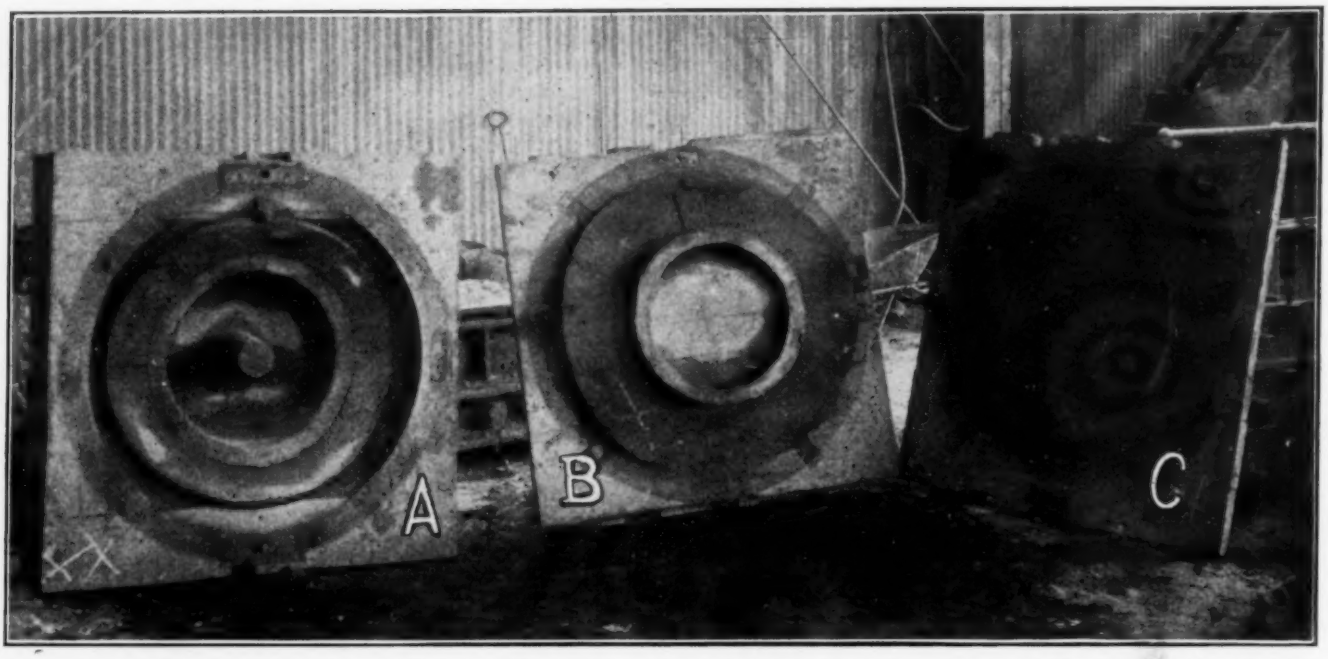

FIG. 6—DRAG, CHEEK AND COPE PATTERN EQUIPMENT DESIGNED TO BE USED WITH A MOLDING MACHINE FOR MAKING STEEL SADDLE CONNECTIONS

draw molding machines made by the Osborn Mfg. Co., Cleveland. One of these machines equipped with board and half a split pattern for a 6-inch gate valve body is shown in Fig. 5. After the mold is jolted, rolled over and the pattern drawn, it is run out from the machine on a small transfer car and placed in position where the crane may be attached to convey it to the drying oven.

A gate connecting with one or more flanges, depending on the size and shape of the casting, is attached to the drag half of the pattern and leaves its impression in the drag half of the mold. It is claimed this method of gating the casting is more satisfactory than that practiced in many foundries where an individual gate is cut to each mold with a piece of bent tin or a lifter and where the size and shape of the gate is left to the judgment of the particular molder engaged for the time being in making that mold. All the hazard incident to carelessness, errors of judgment and lack of skill on the part of the operator are eliminated by the permanent gate attached to the pattern. The method also saves considerable time. It is regarded as one of the many important factors in securing a uniform product that is destined for very severe service.

Drying facilities are provided for the molds and cores by two, car-type ovens supplied by the Swartwout Co., Cleveland. Both ovens are located inside the foundry, one close to the wall at either side and about midway between the two ends of the building. One oil-fired oven, 10 x 12 x 30 feet operates 24 hours a day, is used exclusively for drying the molds and handles an estimated load of 150 tons. This oven is not shown. The entrance to the second oven is shown to the right in Fig. 8. Cores are made on the section of the floor in front of the oven and along one side of the building as may be noted

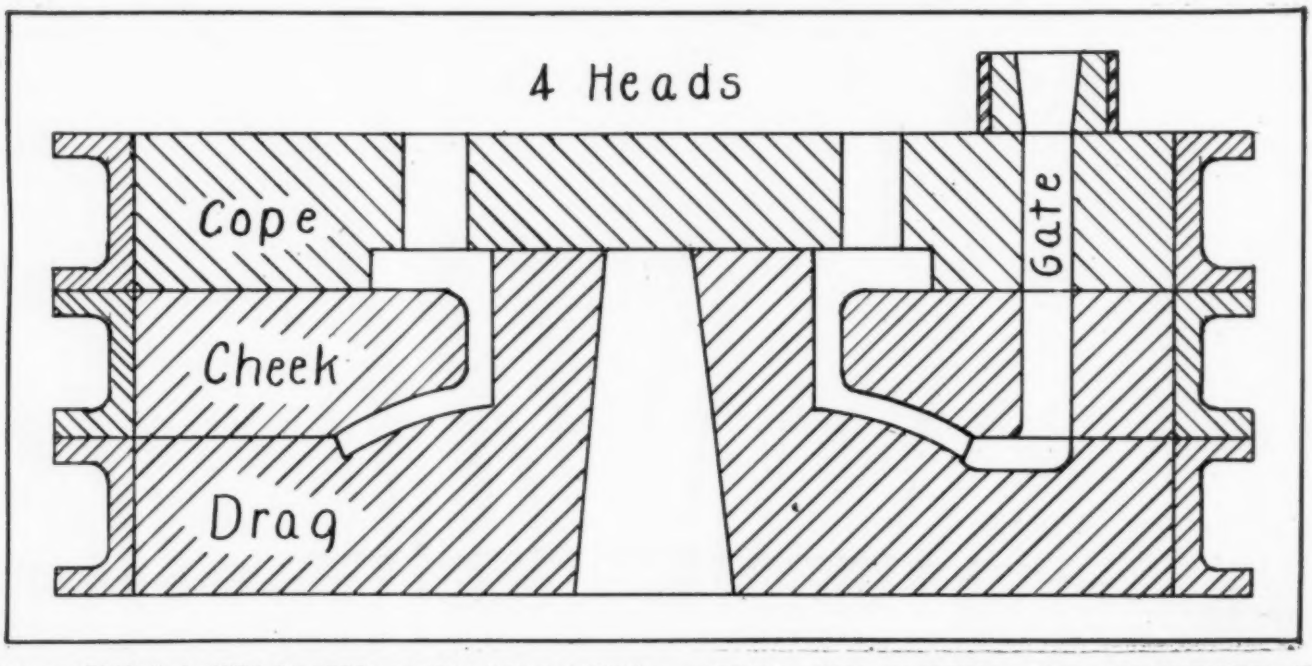

FIG. 7—SECTIONAL VIEW OF STEEL SADDLE MOLD SHOWING PARTING LINES TOGETHER WITH ARRANGEMENT OF GATE AND RISERS

in Fig. 2. The small oven cars are loaded two or three tiers deep before they are placed in the oven. Iron blocks or rings serve as piers at the corners of each core plate to support the plate immediately above.

A typical large gate valve body core is shown in Fig. 8. These cores are made and dried in halves and afterward pasted together. The outside surface is reinforced by nails slicked flush and the inside of the core is strengthened by pieces of scrap rod or pipes. A large cavity is scooped in the interior of each core, primarily for the purpose of permitting the sand to crush under the contracting strain of the metal in the casting. However, the cavity also serves to lighten the core, save sand and lower the drying time in the oven.

The method shown in Fig. 3 has been adopted for molding and pouring flanges and some other castings that are destined for exceedingly high pressure service. The flanges are cast in a vertical instead of the usual horizontal position and are assembled for pouring in groups of 8 to 12, depending on the size. The disposition of a runner and feeding head on a valve ring casting may be noted at the left in Fig. 3. A round gate stick attached temporarily to the set gate, *A*, Fig. 3 is rammed in each flask section and after it is withdrawn, provides a continuous passage for the metal from a single central runner terminating in the pouring cup *B* shown in the same illustration.

Molds Stacked Horizontally

Each flask section forms a cope and drag in itself. The mold impression is formed in one side of the flask and the flat side on the other face of the flask serves as a cope. After the molds are dried they are assembled on a flat bed on the floor. They are arranged as shown with adjoining faces touching each other. A bottom plate is placed against each end of the row and the entire assemblage is bound together tightly by two long bolts, one on either side attached to a section of steel channel beam. Miscellaneous pieces of plate are erected inside the tie rods and the space between the plates and the ends of the various flasks is rammed full of sand to prevent the metal from running out in the event that adjoining faces of the molds do not coincide perfectly.

It is claimed that the foregoing method produces more satisfactory castings than any other which has been tried in this foundry. Also the time and labor involved in removing the feeding heads has been reduced considerably. They are cut off with a torch so neatly that in many cases no further machining is necessary.

Among the miscellaneous jobbing work handled at various times, the pattern equipment developed for making a saddle flange connection shown in Fig. 6 furnishes an interesting example of how modern mechanical devices and methods have been applied to what usually is considered a strictly hand molded casting. To avoid any misconception it should be stated that the three pieces of pattern equipment shown in Fig. 6 are not all for the same casting. They were assembled for photographic purposes merely to illustrate the general method employed. Some of these castings have one flat and one curved flange while in others both flanges are curved. In Fig. 6 the left and center pieces of pattern equipment *A* and *B* are employed for making the drag and cheek respectively of a double curved casting. The pattern board on the right, *C*, is employed for making the cope on those castings where the flange is flat.

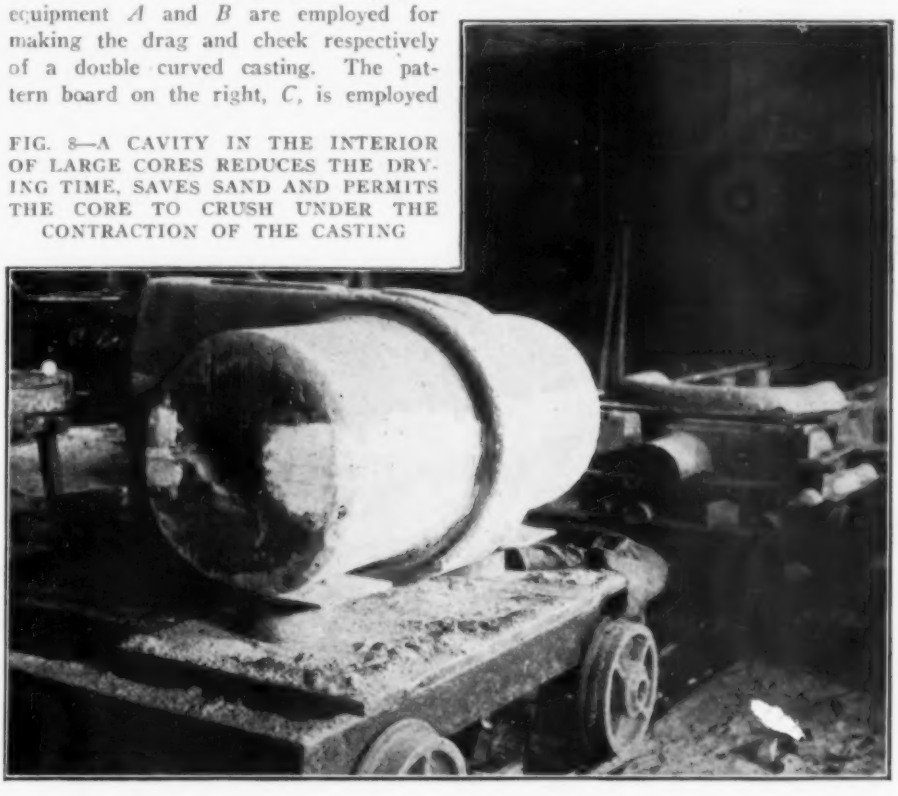

FIG. 8—A CAVITY IN THE INTERIOR OF LARGE CORES REDUCES THE DRYING TIME, SAVES SAND AND PERMITS THE CORE TO CRUSH UNDER THE CONTRACTION OF THE CASTING

In some cases entirely new patterns were constructed and attached to the bottom boards, in others old patterns were attached to boards and the necessary auxiliary parts added to form a parting line at each flask part joint. The manner in which these patterns usually are constructed for hand molding lends itself readily to machine production. The bottom flange constitutes one part while the upper flange and the connecting ring forms the second part. In ordinary hand molding practice the drag is rammed first and rolled over. A parting conforming to the contour of the upper line of the flange is made with the trowel and then the second part of the pattern is placed in position on the lower half. The cheek then is set on and rammed full of sand with the usual delay incident to setting gaggers and ramming sand under and around a series of chuck bars. A second parting is made, this time along the upper line of the upper flange after which the gate stick and risers are set and the cope is rammed and lifted off in the usual manner. The upper part of the pattern is drawn before the cheek can be lifted. After the various parts have been finished and if necessary, dried, they are reassembled and the mold is made ready for pouring.

With the equipment shown, this procedure has been changed to a radical extent and the production increased accordingly. Machined, interchangeable flasks have been provided and as a result a definite number of copes, drags and cheeks have been rammed on a jolt rollover and a plain jolt machine. Each part is made independently of the others and loaded on the oven cars. After they are dried they are taken to the pouring floor and assembled ready for the metal. The hand work practically all has been eliminated. No gate to cut, the gate is attached to the pattern and leaves its own impression. No parting lines to make, the parting is perfect when the mold part is removed from the pattern board. Where the flanges are exceedingly wide, rods are laid horizontally in the center of the cheek to reinforce and support the comparatively narrow body of sand projecting toward the center, all around. In other instances where the flanges are comparatively narrow this precautionary measure is not considered necessary.

The drag is rammed on the pattern board *A*, Fig. 6. It is rolled over, the

(*Concluded on page* 605)

Foundries on Our Men of War

Severe Demands Placed on Battleships in Time of War Together with the Long Periods the Ships Remain Away from Home Ports Necessitate Complete Foundry and Machine Shop Equipment Aboard

BY LIEUT. COMMANDER A. M. CHARLTON

A MAN of war constitutes a vastly different type of ship than a merchant vessel. The only reason for the existence of the war ship is for fighting and it is designed with speed enough to get to the scene of action, with endurance enough to remain there, and with ammunition and gun control sufficient to fight the guns. All of the other functions are subordinated to these. Thus the principal parts of the machinery are concerned with motive power and armament. The remainder of the equipment is installed on account of the personnel, to preserve the health and morale of the crew and thus maintain their *fighting edge*.

Even on as small a vessel as a destroyer, the total amount of machinery is tremendous when compared with that on a merchant vessel of the same displacement. Naval vessels are designed for a certain full power speed, which is called for but occasionally in time of peace, and which in war times may be maintained for but a comparatively few hours without refueling. Normal cruising speeds of war vessels will not take more than 10 per cent of the full power of which the vessel is capable. To get the high speeds demanded on the allowed displacements and weights, factors of safety are cut and the machinery is forced to extreme limits.

On the other hand, merchant vessels are designed for a certain full power speed which is approximated closely all the time the ships are in operation. The machinery and boilers are designed with large factors of safety, and forcing is unnecessary except in emergencies. Vessels are built to run along month after month at a nearly constant speed which is well inside the upper speed limit. Usually they have a fixed run, that is they leave their home ports for a certain number of ports of call, and then return. Minor items of repair and overhaul are accomplished by the ship's force if at sea, and with the help of repair facilities in the ports visited. After a certain length of time in service, a vessel is withdrawn from the run for a long enough period to be given a thorough overhauling at the company's home port. Therefore, it is unnecessary for a merchant vessel to carry a large supply of stores and spare parts for the machinery or to be fitted with extensive shops.

The operating conditions of naval vessels are entirely different from those of merchant ships. Men of war usually cruise in groups, and ships are required to keep station at all times. During maneuvers, many and sudden changes of speed are demanded, changes from five to nineteen knots being of frequent occurrence on a battleship perhaps several times in an hour. These sudden changes in speed are in themselves very wearing on the machinery installation, due to the varying loads put on the engines and boilers. A warship may not see the home port for several months even in peace time, and in time of war it may be away years, if it ever gets back. It is necessary, then, that a man of war be as nearly self-sustaining as possible. A great variety of stores and spare parts must be carried, drawings of the details of every part of machinery are kept in the files, and as many shop facilities, as may be accommodated on board, are installed. In the case of some types of vessel these shop facilities are quite limited, while

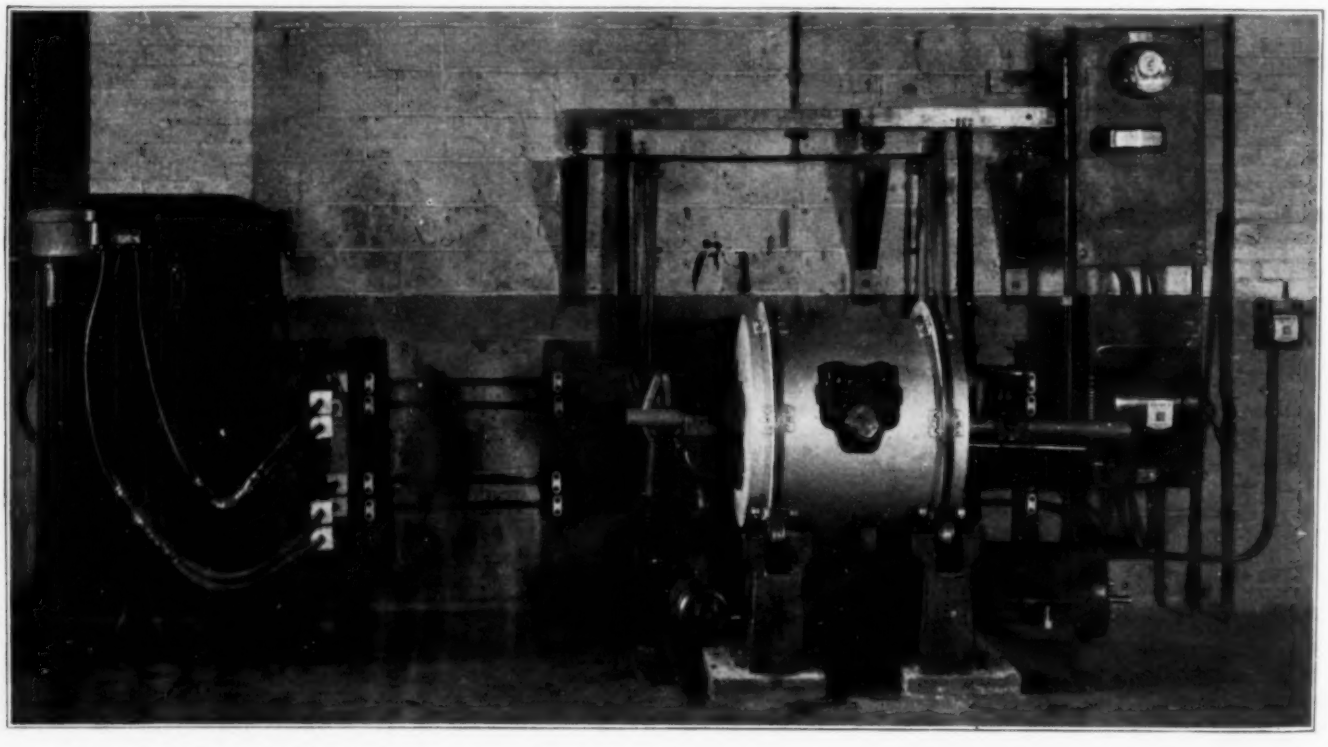

FIG. 1—FURNACES OF THIS TYPE ARE BEING INSTALLED IN THE AIRPLANE CARRIERS SARATOGA AND LEXINGTON

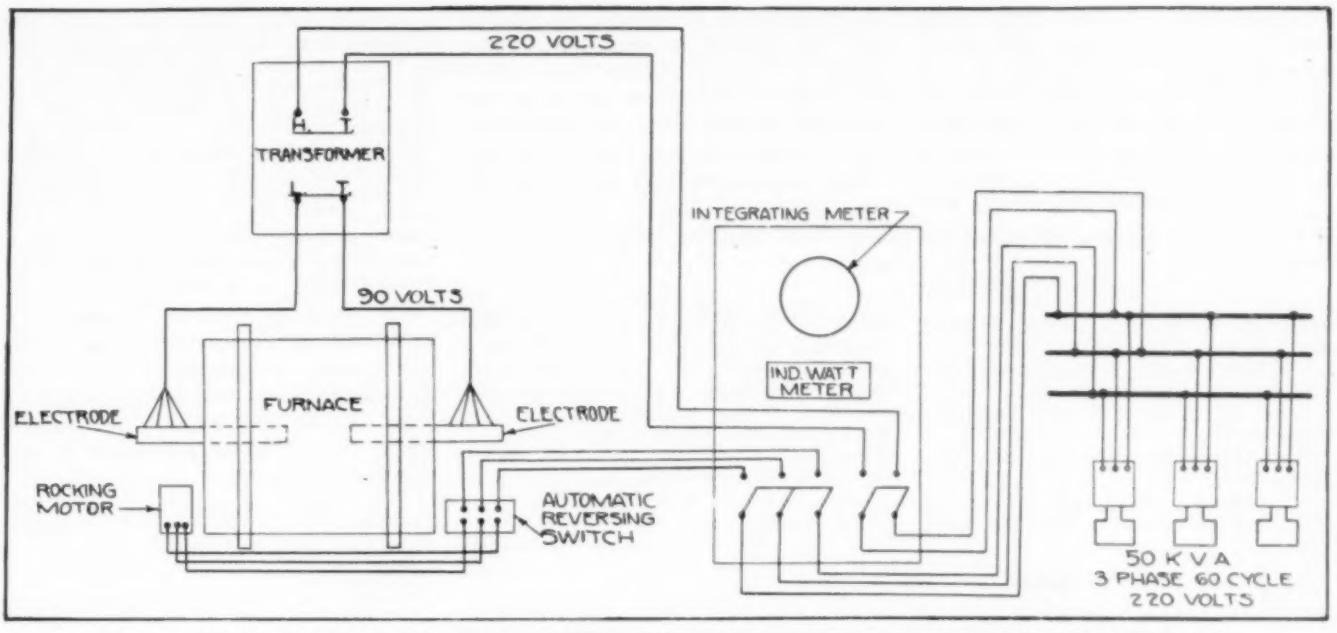

FIG. 2—WIRING DIAGRAM FOR THE ELECTRIC FURNACE USED ON THE SARATOGA AND LEXINGTON

on other types they are very extensive. Thus, a battleship has a large machine shop, a blacksmith shop, carpenter shop, foundry, coppersmith shop and electrical repair shop, while a destroyer has nothing more than a small lathe, a grinder and a drill press.

To supplement the work which may be performed by the ship's force, the fleet is accompanied by repair ships, store ships and tenders for destroyers, submarines and air craft. These vessels have very elaborate shop equipment and have the capacity to turn out some surprisingly large jobs of repair.

Foundry Work Important

Not the least in importance is the work done by the foundries of the various vessels. This article is written to describe in general the foundry equipment on vessels of the United States navy, and the personnel who operate it.

The present allowed complement of the navy is 86,000 men. Out of this number, about 100 are designated as molders first and second classes. Under the supervision of the officers in charge of the shops, these men do all of the founding performed afloat. The pay of these artificers ranges from $72 a month for molders second class in their first four years of service, up to $105 a month for molders first class after 20 years of service. These rates of pay are of course in addition to food and quarters. Other allowances and the privilege of retiring after 16 years of service, make the navy attractive to a man who is willing to undergo the discomforts attendant on any sort of seagoing. No men have been enlisted as molders in the navy since 1919. At that time, when the number in the service was reduced after the war, there were a large number of men in the rate of molder. Since that time such men as have been needed to fill vacancies in the rate of molder have been selectd from those trained in the service, primarily on repair ships.

Molders are assigned to the various types of ship as follows: Battleships, one, tenders, two to six depending on their equipment, and repair ships, 12. These men have been found proficient by examinations, both written and practical, before being rated. When a man is the only one of his rate aboard a battleship, and he is directly responsible for the success of the castings made on that ship, he must have a thorough knowledge of the various branches of the art.

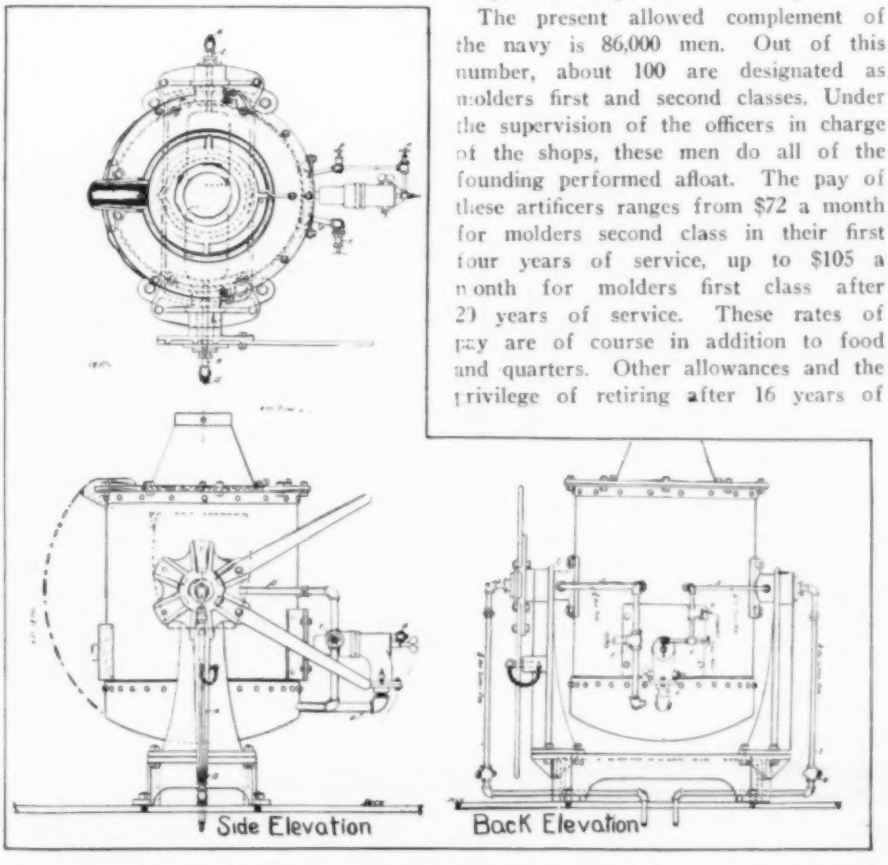

FIG. 3—A TILTING TYPE OIL BURNING CRUCIBLE FURNACE IS USED ON THE U. S. S. TENNESSEE

Foundry Located Below

On the earlier battleships, when foundries were installed, the furnace was situated below decks, usually in an uptake compartment. These compartments are difficult to ventilate and when the ship is underway the heat from the boilers makes them almost unlivable. Little work can be done in these foundries particularly at sea, and they remain more or less in the category of emergency equipment.

On the later battleships, the foundry, coppersmith shop and blacksmith shop have been incorporated in one compartment on the upper deck which may be supplied with plenty of fresh air and from which the gases from the furnaces may be easily exhausted. Figure 4

shows the layout of this compartment on the U. S. S. TENNESSEE. The equipment furnished to battleships is not very extensive, the following being the allowance laid down by the United States bureau of engineering:

One marine oil burning tilting crucible furnace.
Five No. 35 crucibles 125-pound capacity.
Three No. 70 crucibles 230-pound capacity.
Lifting tongs and pouring shanks for the above crucibles.
Molders' tools such as shovels, rammers, riddles, slicks, etc.
Two 12 x 16 x 6-inch cast iron flasks.
Two 18 x 24 x 10-inch cast iron flasks.
Workbench, sand trough, scrap metal bins, tool locker, racks, fuel oil tanks, etc.

Room Well Ventilated

From the plan it will be seen that the crucible furnace, the coppersmith's forge and the blacksmith's forge are grouped around the main smoke stack, and all are situated under a hood which exhausts into the stack. The room has two large doors and two skylights overhead, which may be opened for ventilation. In addition to these, an exhaust blower is located on the deck above the foundry which draws air from the room and exhausts it to the atmosphere.

The crucible furnace shown in Fig. 3, was furnished by the Mirces Fuel-Oil Equipment Co., Lancaster, Pa., and was designed to meet the following specifications:

To consist of a wrought steel plate cylindrical casing, supported on cast iron trunnions, balanced so as to be tilted easily by means of convenient hand levers for pouring the molten metal, the trunnions to be carried in cast iron standards drilled for bolting to the deck; the casing to be lined with best quality fire brick and thoroughly insulated with asbestos, and to have properly proportioned heating and combustion chambers. The heating chamber to contain a No. 70 standard crucible, securely set and supported. The top of casing to have a cast iron cover plate bolted so as to be easily removable for reclining the furnace; to have an air expansion and heating chamber so arranged and connected with the oil burner that compressed air, at any ordinary pressure, is conveyed to it by piping, there to atomize and mix with the fuel oil which is fed to the burner, the burner to operate with any commercial grade of fuel oil, at about 25 pounds pressure or over, furnished with the necessary piping, valves, and fittings of brass, ready for operating; the burner to be so connected that it may be operated continuously while pouring, or the furnace tilted in any position, and of capacity to maintain temperature up to 5000 degrees Fahr. in the heating chamber. The floor space required about 4 feet square. Later vessels have their furnaces large to take a No. 150 crucible.

The remainder of the equipment is stock material, carried by the navy yards, and obtained on requisition. To show the volume of work which is expected from a battleship foundry, the list below is the six months allowance of expendable stores:

Metal, Ingot or Pig

	Pounds
Aluminum	10
Antifriction	200
Antimony	50
Bronze scrap	100
Composition	100

	Pounds
Copper	100
Pig iron	200
Lead	200
Tin	200
Zinc	200

General Supplies

	Pounds
Borax	20
Fire clay	100
Facing, charcoal	50
Facing, silica wash	50
Facing, sea coal	50
Facing, plumbago	50
Flour	50
Fluorspar	50
Gravel	50
Limestone	50
Parting	50

	Pounds
Sand carborundum	100
Sand, Jersey	100
Sand, beach	200
Sand, coarse	500
Sand, molding	1000
Ganister, ground	1600
Molasses, gallons	5
Wax tapers, boxes	2
Furnace bricks	20

Although limited primarily to composition castings with a capacity of some 200 pounds at a single heat, the foundry of a battleship is very useful, and is kept busy most of the time. An enormous amount of the metal in the thousand and one machines aboard a battleship is of brass or bronze, and the breakage of some small part is a daily occurrence.

Make Repairs Immediately

If no spare is available to replace the broken part, and it is needed immediately, a pattern is made and a heat got ready regardless of the time of day or night. The shops may be turned to any time, if necessary. The general practice of the navy is *when something breaks fix it.*

On the new airplane carriers SARATOGA and LEXINGTON, which are being converted from the battle cruisers of the same names, a departure from the usual oil-fired crucibles has been made.

The vessels have a flying deck covering their entire length and width, ex-

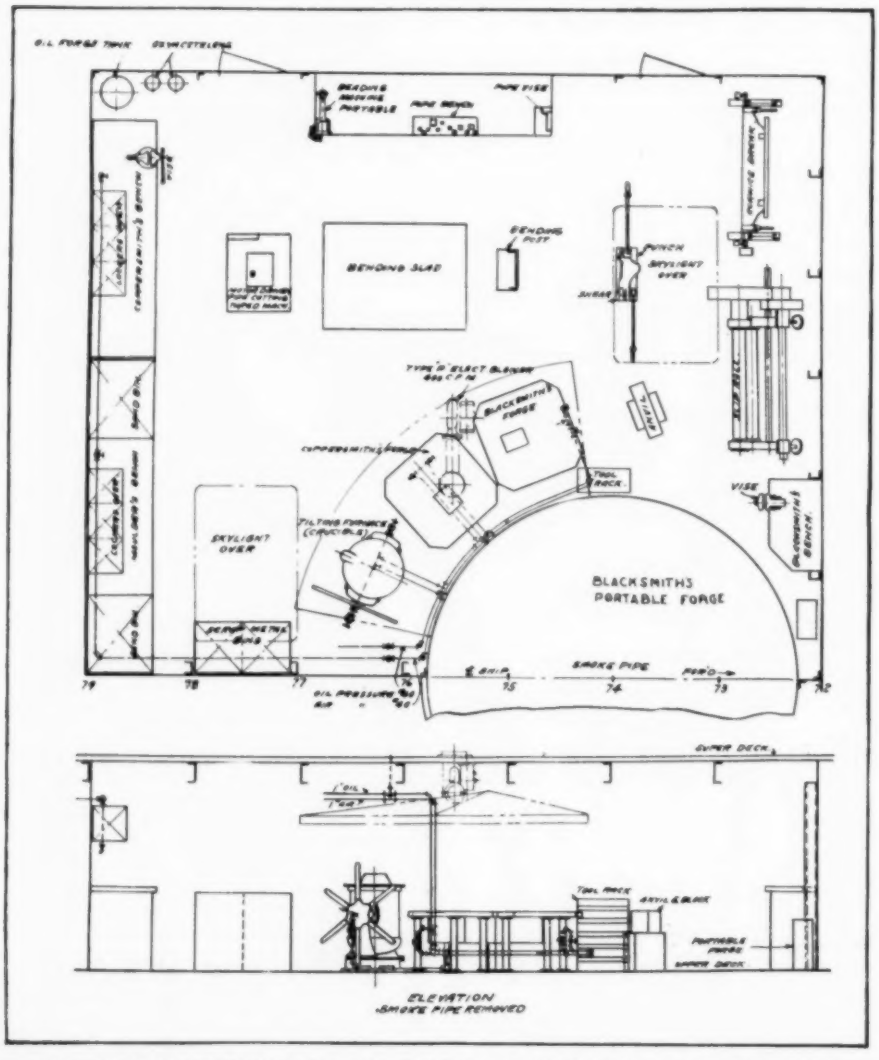

FIG. 4—ARRANGEMENT OF THE FOUNDRY ON THE U. S. S. TENNESSEE

cept for a small portion where the stack and navigating platforms come through. Thus it is impossible to put the foundry on the *top-side* where it may be ventilated easily. For this reason, and because there was plenty of generator capacity on board, it was decided to install electric furnaces for melting nonferrous alloys and steel. After studying the various equipments offered for the purpose, a 200-pound rocking furnace made by the Detroit Electric Furnace Co., Detroit, was selected. The photograph which is reproduced in Fig. 1 shows the type of electric furnace to be installed on the LEXINGTON and SARATOGA.

The furnace equipment consists essentially of a cylindrical furnace shell assembled on two ring tracks which are set on roller bearings. During a heating operation a rocking motion of the furnace is set up by means of a motor mounted on the furnace base, operating a drive shaft through a worm gear. An automatic reversing switch is located on the furnace base. Positive and negative carbon electrodes enter the furnace chamber at opposite ends of the cylinder at the axis of rotation. Provision is made for hand feed of the electrodes.

The furnace shell is approximately 2 feet 6 inches in diameter by 2 feet 6 inches long. Overall length of furnace with electrodes in place is about 5 feet 9 inches, and overall height from the deck about 4 feet.

The method of obtaining current supply for this furnace is rather interesting. The turbogenerators on the vessel for supplying light and power for the auxiliaries are direct current machines, generating 240 volts. As the furnace is built for alternating current, the direct current must be transformed. This is done as follows: Three 50 kilovolt-ampere motor-generators are installed on the vessel which supply 220 volt, 3-phase 60-cycle alternating current for use with induction motor submersible pumps. These three alternating current generators are connected to a common bus, and the current from one phase is used for the furnace. It goes first to a single-phase 60 kilowatt transformer where the current is stepped down to about 90 volts. This 90-volt single phase current is led through a switch to the electrodes of the furnace. Fig. 2 shows the electrical connections for this furnace. The rocking motor is ¾-horsepower, 220-volt, 3-phase current for which is obtained from the common bus of the motor generators.

Although this furnace is intended primarily for the melting of nonferrous metal it also may be used for melting steel by using a separate furnace shell which is to be provided.

The rocking motion of the shell is said to assure a perfect mixing of the metals in the alloy, which prevents the heavier metals from sinking to the bottom of the melt, while preventing at the same time the volatilization of the lighter metals.

By the use of the electric furnace the following advantages are obtained over the oil fired type of furnace: Smoke and gases are eliminated; no fuel to handle; rate of production increased; metallic losses reduced; greater economy throughout obtained; complete control of the characteristics of the alloy possible at all times.

Submarine tenders, such as the HOLLAND which is now under construction at the navy yard, Puget Sound, Wash., have equipment identical with that put on battleships.

The two new destroyers tenders, the DOBBIN and the WHITNEY, now almost completed at the navy yards, Philadelphia and Boston, respectively, have more elaborate installations. Their specifications call for the following foundry apparatus:

One 1½-ton cupola with electric driven blower.

Two marine oil-burning tilting crucible furnaces to take No. 70 crucibles.

One portable core oven 51 x 36 x 36 inches.

Lifting tongs, pouring shanks, hand ladle, bull ladle, riddles, rammers, slicks, etc.

Six 12 x 16 x 6-inch cast iron flasks.

Six 18 x 24 x 10-inch cast iron flasks.

Work bench, sand trough, scrap metal bins, tool locker, racks, fuel oil tanks, etc.

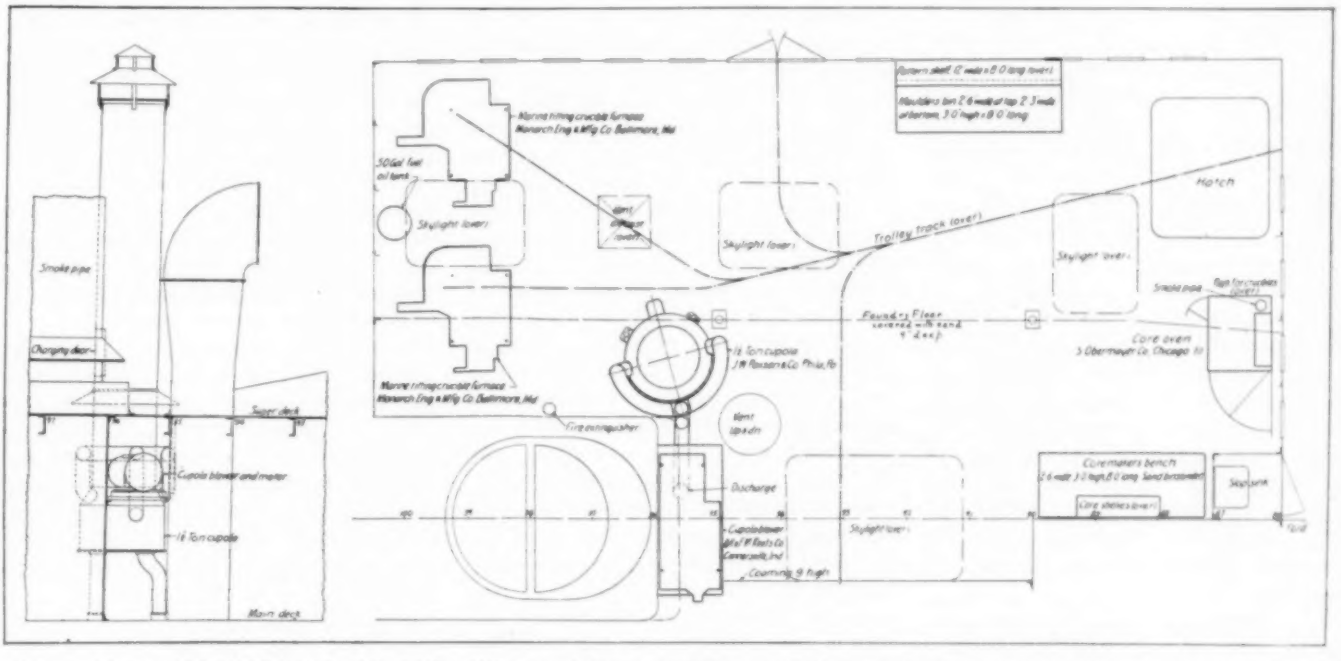

FIG. 5—LEFT—ARRANGEMENT OF THE CUPOLA—RIGHT—GENERAL LAYOUT OF THE FOUNDRY ON THE U. S. S. DOBBIN

The plan Fig. 5 shows the arrangement of the foundry on the DOBBIN, as well as the names of the manufacturers of the various items of the equipment.

The list of articles cast in the foundries of these vessels covers an extremely wide range, although, as can be gathered from the list of equipment, none of the castings is very large. Such things as grate bars, piston rings for pumps and engines, cross head brasses, cooking range lids, air separators, mushroom anchors, airport covers, gears of all sizes, pump plungers, valve seats and valves, cylinder heads, fuel oil burner parts, are only a few items

from a list which might be extended indefinitely.

The cost of many of these items is high because they are made in small quantities, but when a vessel is unable to run a necessary piece of machinery until broken parts are replaced, the cost must be assumed. On the other hand, work can be turned out completed in a surprisingly short time due to the fact that all of the shops are close together and under the supervision of a single officer who may route the work as he desires. Thus a certain urgent piece of work may be run right through the pattern shop, foundry and machine shop with no interruption if it is deemed necessary to get the broken machine in operation in a short space of time.

Repair ships have larger foundry equipment than any vessels described in this article. The foundry equipment on the U. S. MEDUSA, the first repair ship to be built as such, will be described in another article appearing in an early issue. The MEDUSA has probably the largest foundry on any vessel afloat.

Investigates Many Foundry Problems

BY J. G. PEARCE

TECHNICAL work involved in rendering new knowledge serviceable to a particular industry is of such importance that a new vocation has arisen, that of industrial research worker, whose function in an industrial organization is to insure that his industry, through a properly organized research department, shall make the fullest use of new developments. This work practically is confined to the larger industrial establishments.

The war developed greater activity along research lines in England. In 1915 the deficiencies in the supply of war material, due to the shortage of trained research workers and the lack of application of science in industry, were so pronounced that a special committee was appointed to consider the research in its relation to industry, training of research men, aiding existing researches, and encouraging the necessary liaison between science and industry.

The British Cast Iron Research association, one of a number of research bodies resulting from the previously mentioned investigation, was organized in 1921. The member-firms include gray iron and malleable iron founders and engineers in the mechanical, electrical, textile, marine, automobile and other industries. Users of cast iron who are not founders also are accepted as members.

An important feature of the association is the technical bureau through which any member of the association may obtain information on any aspect of the foundry industry. The association receives a large number of books, technical periodicals and papers in various languages, and is in close contact with other technical libraries in various sections of the country. The bureau also keeps investigators and members advised of any advances in any subject in which they are interested. The association issues two kinds of publications, namely the research reports prepared when an investigation is completed, and a quarterly bulletin.

A number of investigations are in progress at the present time. One, to determine the fundamental properties of cast iron, is being conducted in the metallurgical department of the University of Sheffield. It was initiated to determine causes of defects arising through shrinkage and draws in foundry castings. A form of casting was designed to show these defects in a maximum degree. Investigation has shown over twenty direct causes of shrinkage and draw defects in castings, about 70 per cent of which are associated with foundry technique, that is with molding, gating, pouring and melting processes. The remainder are connected with the constitution and treatment of the metal itself.

An investigation on automobile cylinder and piston castings has been undertaken at the University of Birmingham to determine the influence of heat upon the expansion and permanent distortion of pistons up to and including temperatures of 800 degrees Cent.

Another study is in progress at the works of the British Thomson-Houston Co., Rugby, to obtain detailed information on the resistence to erosion of molten metal, gas permeability, heat conductivity, and other properties of British molding sands and sand mixtures together with methods by which used molding sands may be reclaimed.

A joint committee has been appointed to investigate cast irons to resist high temperatures. Such metals are used in the manufacture of glass bottles where exceptional heat resisting qualities are required. The Glass Research association now is testing commercially the use of molds which have been prepared from mixtures resulting from this investigation.

The association is co-operating with the Institute of British Foundrymen and the British Engineering Standards association in developing a standard test bar and the accompanying specifications. The association also is co-operating with a research being conducted at the University of Manchester on graphitization of cast iron.

An important investigation is being conducted at the University of Sheffield on a series of irons to resist various types of corrosion. Irons are being made in a cupola completely under the control of the investigator and also under ordinary commercial conditions these are subjected to a range of tests. A research is being conducted on the influence of nickel and chromium on the graphitization of iron. This investigation is of particular interest to malleable iron manufacturers.

The electric and magnetic properties of cast iron, both ordinary and special mixtures, are being investigated at the University of Birmingham. Other important work is being undertaken by the association, for example, an important report being in preparation on British cupola practice to enable members to standardize on practice which gives the best results.

The field of research open to the association may be indicated as follows: Fundamental metallurgical research upon cast iron, malleable iron and toughened cast iron; the production, remelting and after treatment of cast iron; auxiliary materials used in foundry practice; development of particular irons to meet particular specifications and classes of service; standardization of materials, tests and specifications; study of failures.

From a paper presented at the London, England, meeting of the Empire Mining & Metallurgical congress, June 3-6.

Making Synthetic Iron

A series of tests in making synthetic cast iron in a commercial electric furnace has been completed by the department of interior engineers at Seattle. Both synthetic gray iron and mild steel were produced in alternating runs without trouble. Miscellaneous steel scrap of all kinds was charged into the furnace to produce various grades of iron. The results show that, under the conditions in this foundry, the synthetic product may compete with cupola iron, and is superior in quality and strength.

Making Motorcycle Cylinders

Work Is Cast In Two or Three Part Molds—Pouring Effected in Many Different Ways—Special Device Used for Stripping Fins into Pattern of the Cylinder Barrel

EUROPEAN methods of making motorcycle cylinder castings are described in a paper read by Joseph Leonard, vice president of the Association Technique de Fonderie de Liege, Belgium, at a meeting of the Association Technique de Fonderie de France, held recently in Paris. M. Leonard is manager of a cylinder foundry at Farciennes, Belgium. In the introduction of his paper he lays particular stress on the necessity for co-operation between the designers of automotive equipment and the foundrymen who are called upon to make the castings required for this class of work.

M. Leonard said that the average chemical analysis of the pig iron which he uses for motorcycle cylinder castings is as follows: Silicon, from 2.50 to 3.00 per cent; manganese, 0.8 to 1.00 per cent; 1 phosphorus, 0.8 to 1.00 per cent; sulphur, 0.08 to 0.12 per cent; total carbon, 3.2 to 3.3 per cent. Pig iron answering to this analysis has a brinell hardness of 190 to 200. This figure lies midway between the soft pig iron sometimes used in Belgium which has a hardness number from 170 to 180 and that usually employed in Great Britain which has a brinel hardness which ranges from 210 to 220.

The author said it is necessary to use metal patterns for this class of work. In Belgium they usually are made of brass or bronze, although for machine molding, white-metal patterns with stripping plates may be used. Certain types of cylinders can be cast in two-part flasks; others require three-part flasks. In the latter case the middle portion of the pattern is made in two parts so that it can be drawn out from either side. This arrangement is illustrated in Fig. 1, the dotted line showing the parting in the middle of the pattern. In certain cases it is necessary to use two-part flasks and to form a portion of the mold by a core inserted in the cavity left by a print attached to the pattern, as shown by the shaded portion of Fig. 2. A special device may be used for stripping the fins into the pattern of the cylinder barrel by means of a single lever.

Hand Molding Methods

In certain districts in Belgium, hand molding still is employed. The product thus obtained is remarkable for its fine finish, but where the output attains large proportions, only machine molding can give efficient results. Hand molding needs special skill whereas machine molding does not require highly trained workers. Squeezer machines usually are employed although the author prefers to tuck certain acute angles, and in between the fins, by hand. In most cases where difficulties are encountered, it is because green sand is used in shops designed for dry sand methods, although the use of green sand also has given good results after careful study. The jolt-ramming machine is successful when the sand is mixed with a binding material and first applied against the delicate parts with a small stick, after which operation the jolt ramming takes place.

When green sand is used, the resistance to erosion at the bottom of the gate may someimes be insufficient, resulting in sand being carried into the the casting. In this case, it is advisable to dry the mold after having covered the runner pin with sand mixed with a binding material which becomes hard when the mold is dried as shown in Fig. 3,

Pouring can be effected in many different ways. In one particular case the metal was poured through the core *B*, Fig. 4, and this gave good results. In England the author saw castings poured at the top as at *C*. However, in most cases bottom pouring as at *A*

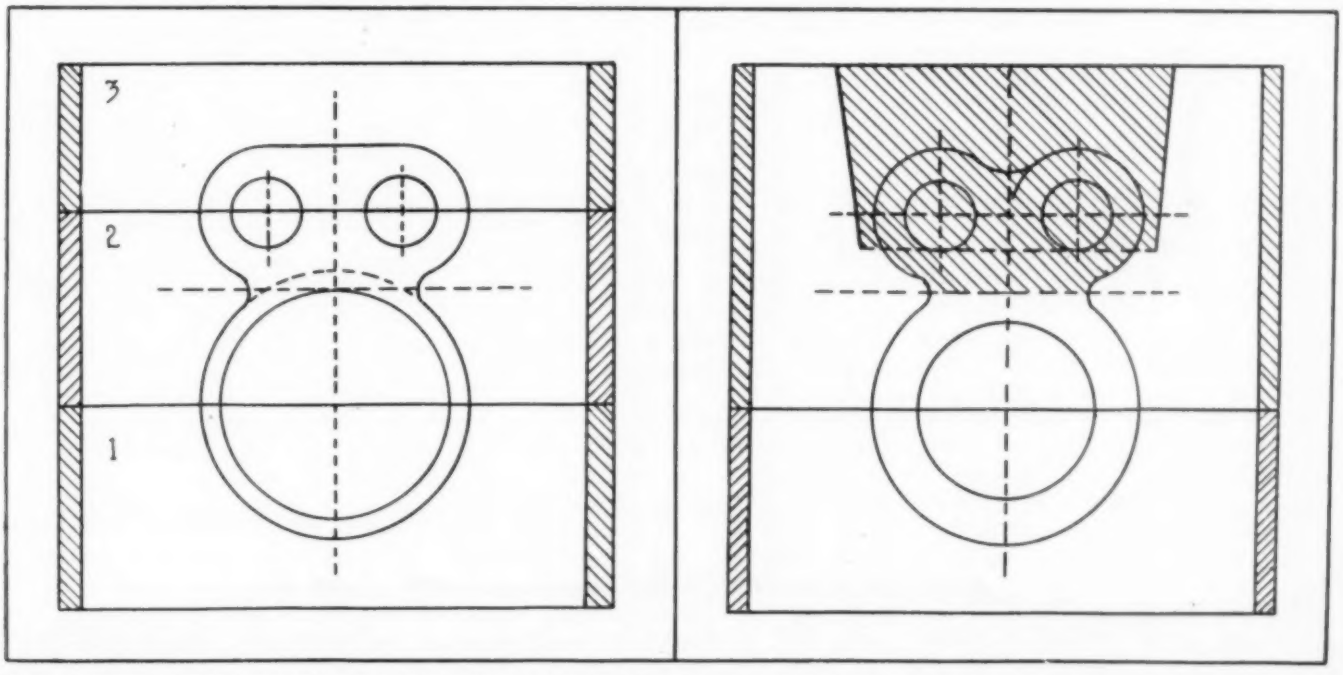

FIG. 1—(LEFT) THE PARTING IN THE THREE PART FLASK IS MADE ALONG THE DOTTED LINE—FIG. 2—(RIGHT) THE SHADED PORTION SHOWS A CORE INSERTED IN THE CAVITY LEFT BY THE PRINT

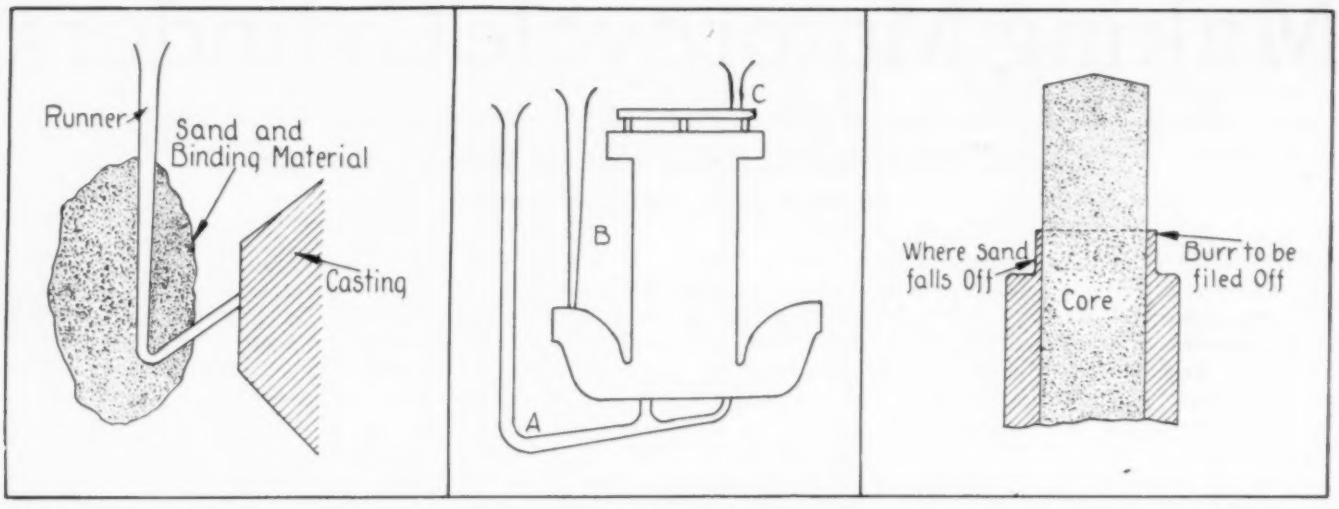

FIG. 3—(LEFT) SAND MIXED WITH BINDING MATERIAL COVERS THE RUNNER PIN—FIG. 4—(CENTER) SEVERAL METHODS MAY BE USED IN POURING THE MOLD FIG. 5—(RIGHT) CORE PRINTS AS SHOWN ARE RECOMMENDED TO KEEP THE SAND FROM FALLING

is recommended. The metal should be poured rapidly and usually it is advisable to use a small pouring basin. Sometimes the fins do not turn out well because the mold has been poured too slowly.

Other causes can give defective fins. It was found once that a molder was using water to repair a mold and a defect constantly reappeared in the fins. When oil was substituted for water the fins were turned out successfully. Core prints as shown in Fig. 5 are recommended to prevent the sand from falling at the corners; the burr which remains can be filed off afterwards. In certain cases when only a small number of cylinders are required, the cylinder barrel is first cast in iron, and an aluminum block poured over it. The fins are then turned out of this block which is reheated to 400 or 500 degrees Cent. in order to prevent the cracks caused by internal stresses in the thinnest parts.

Encounter Difficulty in Breaking Propellers

For the past six or seven years, the Doran Brass Foundry Co., Seattle, Wash., has specialized in the casting of manganese bronze propeller hubs and blades. One of the greatest prolems has been to find some method of breaking up old manganese bronze castings for reuse in their furnaces.

The drop ball method was used without success,although it first was thought that this method would solve the problem. One of the local scrap dealers secured a propeller blade from a Japanese ship placed it under a 3000-pound ball and allowing the ball to fall 50 feet, broke the blade easily. This scrap dealer than approached the Doran company and made arrangements to prepare all of the blades. Unfortunately for the scrap dealer the blade obtained from the Japanese ship was far inferior in quality to those made in this country. In attempting to break the blades furnished by the Doran company, he spent much time and finally gave up the job.

He first tried dropping the ball from a 50-foot height, with the result that not even a mark was made on the propeller. He then tried dropping the ball, first nicking the blade, but the result was the same. He next tried heating the blade thoroughly and dropping the ball on it. This resulted in the blade giving where the ball hit and the ends curling up slightly. He turned the blade over and while still hot, dropped the ball on this side. He only succeeded in getting the ends to curl up in the other direction.

The only method that the Doran company has found to prepare this scrap for reuse is to send it to the forge works where the blade is placed in the top of a oil fired pit furnace and heated a cherry red. It then is placed under the steam hammer and sheared off into furnace sizes. This method is rather expensive as it takes practically all morning to heat a blade weighing 5000 pounds.

H. L. Mode has joined the sales organization of the Florandin Equipment Co., 110 West Fortieth street, New York, and will specialize in the sale in northern New Jersey territory of hoists made by the American Engineering Co., Philadelphia and cranes made by H. D. Conkey & Co., Chicago. Mr. Mode formerly was connected with the New York office of the Chesapeake Iron Works, crane manufacturers.

Penton Company Formed In London

By reason of the great increase in its business in Europe and the constant development of its editorial service, the Penton Publishing Co., Cleveland, publishers of THE FOUNDRY, *Iron Trade Review, Daily Metal Trade, Power Boating, Marine Review, Abrasive Industry,* etc., has incorporated a British company which will have charge of its European affairs hereafter. This company is known as the Penton Publishing Co., Ltd., and its registered offices are at Caxton House, Westminster, London, S.W.1, with branch offices at Prince's Chambers, Corporation street, Birmingham, England, 23 Rue de la Bienfaisance, Paris, and 218 Friedrichstrasse, Berlin.

The growth of the Penton Publishing Co. foreign editorial organization is indicated by the thorough manner in which the activities of European foundrymen and technical advance in castings manufacture have been reported in THE FOUNDRY, and by the numerous articles which have been published dealing with foundry practice in leading countries of Europe. The large circulation of THE FOUNDRY in Europe and the increase in book business of the company indicates further the work of the foreign organization.

The directors of the Penton Publishing Co., Ltd., London, are John A. Penton, A. O. Backert, Charles J. Stark, J. D. Pease and H. Cole Estep.

Move Executive Offices

The Cleveland Stone Co., Cleveland, has opened its executive offices at the Union Trust building, Cleveland. All of its departments, including the grindstone, artificial abrasive, and building stone branches will be located in these quarters.

White Iron for Grinder Disks

Additions of Steel Scrap to the White Iron Mixtures Give High Physical Properties to the Castings Produced in Proportion to the Amount of Scrap Used

BY GEORGE A. DRYSDALE

IT IS essential that grinder disks used in feed mills, coffee mills and numerous other machines of a like nature should have suitable hardness to resist frictional wear, and toughness to resist tear and excessive breakage. To combine these two desired properties in white iron castings has been rather difficult. A great deal of experimental work has been carried on along these lines with different grades and brands of pig iron with additions such as iron-sulphide, ferromanganese, steel scrap, etc., and with various molding conditions to obtain a metal which would add to the life of such castings and reduce the high breakage factor.

White iron usually is melted in the cupola furnace owing to the small amounts required at one time. The usual method of procedure is to charge the mixture into the cupola first on the bed of coke. The number of charges will depend upon the amount of white iron required for the day's heat. This special iron is run off before the regular iron. It is good practice to charge an extra heavy body of coke between the last charge of special iron and the first charge of regular iron, to avoid as far as possible the mixing of the two extremes.

White iron may in a broad sense be divided into two classes, namely, chilled iron, and regular white iron. This article deals with the latter, but it is advisable to distinguish between the two metals to avoid confusion. In the first instance chilled iron is obtained from a regular gray iron mixture where the molten metal is not permitted to set in the usual way in green or dry sand molds but is subjected to certain extreme chilling influences such as iron plates placed in the mold and designated as chills which cause a rapid set of the metal at the surface only or at the points that come in contact with the chills. The carbon is held in the combined state, and the compound cementite or iron carbide, Fe_3C, is formed by mechanical means.

Chilled castings contain iron in its three forms, chilled (white) mottled and gray when gaged by the color of the fracture. From a chemical and metallurgical standpoint, the chilled iron has the carbon in solution in the form of cementite or combined with the iron. In the mottled iron, the carbon is in the combined and graphitic state, the latter condition indicates that the carbon has separated from the iron on cooling in the free state or crystalline form. In the mottled iron, the combined carbon usually predominates. In the gray iron the larger percentage of carbon is in the graphitic or free state.

Regular white iron or the second condition results when molten iron is poured in the regular way into green sand molds and owing to its low silicon or carbon content the metal takes a rapid set thus holding its carbon in the combined state and forming cementite. This combined state is uniform throughout the mass which is the distinguishing feature between chilled and white iron castings.

The following table shows the chemical change in the state of carbon in the chilled iron casting in comparison to the regular white iron:

	Gray iron per cent	Chilled iron per cent	White iron per cent
Silicon	1.75	1.75	0.70
Sulphur	0.09	0.09	0.10
Phosphorus	0.25	0.25	0.20
Manganese	0.75	0.75	0.70
Combined carbon	0.40	3.40	3.00
Graphitic carbon	3.00	trace	trace
Total carbon	3.40	3.40	3.00

The average cast white iron is a brittle metal with low physical properties and consequently a poor metal to resist shock. It has been demonstrated that by additions of steel scrap in the mixture, castings may be obtained that have good physical properties such as hardness, toughness and strength which are essential in making grinder disks. The physical properties are controlled to a great extent by the percentages of steel scrap used in the mixture, in the same manner that steel additions affect gray iron mixtures in producing semi-steel. Precautions have to be taken in the use of steel scrap for the reason that in lowering the silicon-carbon content, the metal becomes sluggish and sets more or the more rapidly in the mold. This governs to a great extent the contraction of the metal on solidification. These conditions must be considered in regulating the correct amount of steel scrap used in the mixture.

It is essential that larger amounts of coke should be used when melting the white iron mixture, to obtain iron as hot as possible when pouring. The white iron castings will run higher in sulphur content than the castings poured from the regular iron. This has been found to be in no way detrimental to the product, as the extra amount of sulphur absorbed from the coke will tend to have a hardening effect on the castings. Sul-

Table II

Cupola Mixture No. 2 for White Iron

Fifteen per cent steel scrap used

	Silicon per cent	Sulphur per cent	Phosphorus per cent	Manganese per cent	Combined carbon per cent	Graphite carbon per cent	Charge per cent
Malleable Bessemer	1.00	0.025	0.18	0.60	0.55	3.05	50
Gray iron scrap ..	2.00	0.085	0.28	0.55	0.40	3.00	15
White iron scrap ..	0.75	0.095	0.20	0.40	3.40	0.05	20
Steel scrap	0.05	0.045	0.05	0.45	0.20	...	15
Average	0.85	0.051	0.18	...	...	...	100

Table I

Cupola Mixture No. 1 for White Iron

No steel scrap used

	Silicon per cent	Sulphur per cent	Phosphorus per cent	Manganese per cent	Combined carbon per cent	Graphite carbon per cent	Charge per cent
Malleable Bessemer	1.00	0.025	0.18	0.60	0.55	3.05	50
Return white iron..	0.75	0.095	0.20	0.40	3.40	0.05	50
Average	0.87	0.060	0.19	...	...	...	100

Table III

Cupola Mixture No. 3 for White Iron

Twenty-five per cent steel scrap used

	Silicon per cent	Sulphur per cent	Phosphorus per cent	Manganese per cent	Combined carbon per cent	Graphite carbon per cent	Charge per cent
Malleable Bessemer	1.00	0.025	0.18	0.60	0.55	3.05	40
Gray iron scrap ..	2.00	0.085	0.28	0.55	0.40	3.00	15
White iron scrap ..	0.75	0.095	0.20	0.40	3.40	0.05	20
Steel scrap	0.05	0.045	0.05	0.45	0.20	...	25
Average	0.86	0.053	0.16	...	...	...	100

phur in the casting may run as high as 0.150 to 0.175 with benefit to the product.

Cupola mixture No. 1, Table I is one which was used successfully in making iron for grinder disks, etc. It was made up of 50 per cent malleable bessemer pig iron and 50 per cent of return white iron. Owing to the amount of return iron available it was often necessary to change the amounts used to 70 per cent pig iron and 30 per cent sprues or returns. It was noted that the mixture carrying the larger percentage of pig iron gave slightly weaker physical properties. In cupola mixture No. 2, Table II, 15 per cent of steel scrap was used to toughen the castings and 15 per cent of gray iron scrap was used to hold the silicon up to 0.85 per cent in the mixture or the required average. In cupola mixture No. 3, Table III, 25 per cent of steel scrap was used. The composition of the two mixtures with steel additions being the same except in their proportions. These three cupola mixtures are typical of a number used for the purposes designated.

The steel scrap used was ordinary 10 to 20 per cent carbon, open-hearth steel in suitable sizes. The physical properties given in Table IV are the average of 6 consecutive heats obtained from each of the three mixtures given, and are typical of the results usually obtained.

The average chemical analysis of the 6 test bars poured from the 3 mixtures (the 1-inch square bar used for the purpose) are as follows:

	Mixture No. 1 per cent	Mixture No. 2 per cent	Mixture No. 3 per cent
Silicon	0.740	0.700	0.675
Sulphur	0.127	0.119	0.130
Phosphorus	0.201	0.192	0.179
Manganese	0.420	0.370	0.360
Combined carbon	3.460	3.070	2.625

It will be noted that the results obtained show a lowering of the total carbon in proportion to the amounts of steel scrap used. The difference in the set of the metal from mixtures No. 1 and No. 3 was quite apparent. The metal from No. 1 mixture was fluid and poured well, but the metal from the mixture No. 3 which contained the 25 per cent of steel scrap was inclined to be sluggish. Although the iron came from the spout hot, this metal had to be handled quickly owing to this condition. This tends to show that there is a limitation in the amount of steel scrap that can be used satisfactorily in the mixture, with the corresponding lowering of the carbon content. The minimum amounts of these two elements are silicon 0.35 per cent and total carbon 2.00 per cent.

The fracture of the bars poured from mixture No. 1 could be designated as showing a cauliflower or fan shaped structure of crystallization. The fracture of the bars poured from mixture No. 2 carrying 15 per cent of steel scrap showed on fracture a coarse-grained structure and the fracture from mixture No. 3 carrying 25 per cent of steel scrap showed a fine-grained structure resembling that of cast steel. These conditions tend to show that the structural formations of the white iron castings are changed by the use of steel scrap and the closeness of the grain depends upon the amounts of steel scrap used in the cupola mixtures. Physical properties of the metal also are influenced.

Notes German Practice

Among the lectures delivered at the International Foundry Trades exhibition at Bingley Hall, Birmingham, England, recently, was one on "Modern Foundry Practice in Germany," by Dr. Siegfried Werner Dusseldorf, Germany, president of the Verein Deutscer Eisengiessereien. Dr. Werner described the warm blast cupola and also dealt with the production of pearlitic cast iron covering in a large measure the ground which he traversed in his lectures in the United States a few months ago.

Dr. Werner also referred to some recent experiments in which an effort has been made to produce high silicon castings by taking advantage of the exothermic reaction at 1100 degrees Cent. between ferrosilicon and steel. In the experiments, steel punchings were scattered over the hearth of a reverberatory furnace along with walnut size lumps of ferrosilicon. At 1100 degrees Cent. Dr. Werner said the exothermic reaction took place and produced almost immediately a highly fluid bath which it was possible to pour into castings.

Dr. Werner also described the German methods of reducing sulphur in cast iron by the addition of potash. It is necessary, he said, to have the cupola fitted with a receiver and to place a siphon slag skimmer between the receiver and the cupola so that the bath to be treated will be free from slag. He claimed that this treatment, in addition to reducing sulphur, increased the machineability of the casting by 30 per cent.

Nominating Committee Makes Report

The nominating committee of the American Foundrymen's association has named the following officers and directors for election by the association: For president to serve one year, L. W. Olson, works manager Ohio Brass Co., Mansfield, O.; for vice president to serve one year, A. B. Root Jr., mechanical engineer, Hunt-Spiller Mfg. Corp., Boston, for director to serve one year, V. E. Minich, president, American Foundry Equipment Co., New York; for directors to serve three years, G. H. Clamer, vice president and general manager, Ajax Metal Co., Philadelphia; John E. Galvin, president, Ohio Steel Foundry Co., Lima, O.; A. E. Hageboeck secretary, Frank Foundries Corp. Moline, Ill.; R. A. Nourse, vice president and general manager, Stowell Co. South Milwaukee, Wis., Wm. J. Nugent, vice president and general manager, Nugent Steel Casting Co., Chicago.

Table IV

Average Physical Properties

	Mixture No. 1	Mixture No. 2	Mixture No. 3
Tensile strength (test bar 1¼ inches round poured flat)..	12,000	24,700	30,500
Transverse strength (test bar 1 inch square 13 inches—long—12 inches between knives dead load at center poured flat)	1,100	2,500	3,200
Deflection (on 1 inch square bar used for transverse strength	0.04	0.10	0.125

Data Meager on Foundry Iron

Investigation of Problems Which Have Developed in Connection with Irons Used in the Foundry Should Be Placed on a Scientific Basis — Carbon Is Most Important Element in Iron

BY R. R. McGOWAN

FOUNDRY iron recently has been studied from a scientific standpoint and present knowledge on the subject is slight. Foundrymen greatly appreciate the information scientists have passed on to them, but much yet must be accomplished before the subject is established on a scientific basis. Among the scientists who have studied the problems and made valuable contributions are W. J. Keep, Thomas D. West and Dr. Richard Moldenke of America and Prof. Turner Dr. Stead and F. J. Cook of Great Britain.

Since iron is a product of the blast furnace, it may be of interest to give a short description of the actions which take place in the production of the iron. A blast furnace consists of a long cone inverted upon a shorter one. A vertical passage called the crucible is located at the bottom of the furnace. Into this crucible the tuyers are inserted for the introduction of the blast and an opening also is provided for the withdrawal of the slag. When a sifficient quantity of the metal is formed in the crucible, it is withdrawn through a tap hole at the bottom. The furnace is fed with ore, coke and limestone from the top, the charge being renewed from time to time as the materials burn down.

The action by which the ore is reduced to the metallic state briefly is as follows: The oxygen in the blast combines with the carbon of the coke to form carbonic acid. The carbonic acid, in its passage through the remainder of the heated charge, is decomposed and converted into carbonic oxide. The assending carbonic acid combines with the hydrogen and coal gas forming a reducing mixture. This mixture abstracts the oxygen from the ore and sets free the iron in a metallic state. The iron flows to the bottom of the furnace where it comes in contact with the carbon in the coke. Carbide of iron then is formed which increases the fusibility of the reduced iron to such an extent that the lime, clay and silica present, which have been converted into a fusible slag, floats on the iron. The slag is withdrawn through the opening in the side and the metal withdrawn at stated intervals.

The pig iron thus produced contains six principal constituents, namely carbon, silicon, manganese, sulphur, phosphorus and iron. The suitability of an iron for any specific purpose depends on the proportion of these elements present. The study of cast iron is made difficult by the many constituents present, and for this reason a difference of opinion exists among foundrymen and even among scientists regarding the effect of these elements on the physical and other properties of the metal.

Carbon Is Important

F. J. Cook states that carbon is the most important element in cast iron, all physical properties depending on the quality of this element present and on its condition. The value of the other elements are judged in accordance with the effect they have on the carbon and the compounds it forms. Carbon appears in the iron in the combined or graphitic form and, the exact percentage of each may be determined. When the iron is in the molten state all carbon which the iron contains is in solution or in other words in combination with the iron and forms what is known as carbide of iron, that is a composition of carbon and iron.

As the metal cools a portion of the carbon is ejected as free graphite and the part remaining is called combined carbon. According to the influence of its constituents, foundry iron may only retain a certain amount of carbon in combination. The action of the iron in retaining and rejecting a portion of the carbon sometimes is compared to the action of sugar when added to tea. The tea will absorb all of the sugar up to a certain point, called the saturation point, and any sugar added after that point is reached is rejected and will be found undissolved in the bottom of the cup.

The amount of carbon retained or rejected by the iron has an important effect on the physical properties of the metal. The chemical analysis of iron gives a certain amount of useful information, but does not give an indication of strength. Two irons may have the same analysis, yet differ in physical properties. The structure of the metal must be examined microscopically to determine the points of difference. To the trained eye, such an examination reveal the differences in conditions which influence the strength of the metal. The use of the microscope introduces the science of metallography a subject of intense interest to the foundrymen and one which calls for a high degree of special knowledge to detect the various effects and conditions in the structure of metals. The science of metallography has established a number of highly important facts, those relating to the condition of the carbon in the iron and the effect of the rate of cooling on the physical properties of the metal being of especial interest to the foundrymen.

When the analysis of the foundry iron is completed, three facts which usually are determined in connection with the carbon are the total carbon, graphitic carbon and combined carbon. Until recently some authorities considered the amount of graphitic carbon of little importance as long as the combined carbon was kept within certain limits. This opinion has been modified since Dr. Stead stated that "The diminution of 0.1 per cent of graphite below 3.2 down to 2 per cent was coincident with an increase in the transverse strength of approximately 224 pounds on the standard bar 36 x 2 x 1 inches and 0.8 tons per square inch on the tensile strength; the other constituents in the iron being approximately constant. It was clear that graphite, so far as the strength of the cast iron was concerned, was an enemy of the cast iron founder."

The percentage of total carbon in an iron may change when passing through the cupola. An increase may take place if the original mixture contains a low percentage of carbon, if a soft blast is used or when the metal is kept in contact with the fuel for too long a period. The total carbon may decrease under the opposite conditions. The condition of carbon is

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Composition of Iron for General Castings

Thickness of Casting, Inches	Silicon	Phosphorus	Manganese	Sulphur
	Per cent	Per cent	Per cent	Per cent
¼	3.25	1.00	0.40	0.025
½	2.75	0.80	0.40	0.040
¾	2.50	0.75	0.50	0.050
1	2.00	0.70	0.60	0.060
1½	1.75	0.65	0.70	0.070
2	1.50	0.60	0.80	0.080
2½	1.25	0.55	0.90	0.090
3	1.00	0.50	1.00	0.100

affected by the following conditions:

(1) The total carbon present in the original mixture. The iron having the greatest proportion of total carbon will have a greater proportion of graphitic carbon to combined carbon in the finishing casting.

(2) Rate of cooling. Rapid cooling increased the proportion of combined carbon while slow cooling increases the proportion of graphitic carbon. A thin casting cast with the same metal as a thick casting will contain the greatest amount of combined carbon.

(3) The influence of the other constituents. High silicon increases the life of an iron and allows the carbon time to separate out from the combined to the graphitic form. Sulphur and manganese act in an opposite direction to silicon. Phosphorus, like silicon, adds fluidity to an iron.

Combined carbon gives strength and hardness to the casting, the element varying in castings made in sand molds from 0.1 to 1.0 per cent. When the combined carbon reaches 1.0 per cent the casting becomes brittle and is difficult to machine. F. J. Cook has determined that the maximum tensile strength of cast iron is obtained with 0.6 to 0.8 per cent combined carbon and the maximum transverse strength with 0.4 to 0.6 per cent. The total carbon in each case should not exceed 3.25 per cent. Although combined carbon is such an important element in cast iron, the amount of this constituent which will be contained in the casting cannot be predetermined due to the effect of the rate of cooling and the influence of the other constituents. An interesting point to note is that the total carbon in foundry iron seldom is below 3.0 per cent and usually ranges between 3.0 and 4.0 per cent. The saturation point is about 4.25 per cent.

Silicon Determines Suitability

Silicon is the element which largely determines the suitability of an iron for any specific purpose due, to the influence which it exerts on the condition of the carbon present. Silicon increases the life or fluidity of the iron, thus allowing more time for the carbon to separate out which reduces the proportion of combined carbon and softens the iron. Comparing castings in which the rate of cooling is equal, those containing the highest percentage of silicon will have the lowest percentage of combined carbon. This fact must be considered when determining the composition of an iron suitable for light or heavy castings, since light castings cool at a much faster rate than heavy castings. If a light and a heavy casting are cast at the same time with the same iron, the lighter casting will contain the greatest proportion of carbon in the combined state. For that reason, the first principal to be considered in determining the composition of an iron suitable for a particular casting may be stated as follows: As the castings tend to be hard and high in combined carbon, iron high in silicon, which tend to be soft and low in combined carbon must be used. Heavy castings, which tend to be soft and low in combined carbon, should be made from irons low in silicon, which tend to be hard and high in combined carbon.

Manganese Value Questioned

However, the suitability of an iron should not be judged by the silicon content alone as much depends on the proportion of the other constituents present and especially the amount of total carbon. A system of grading iron on the basis of the silicon content has been established in America, which has met with a fair amount of success. However, the silicon content does not reveal the true quality of the iron.

Considerable controversy was developed over the manganese in iron, the amount of which varies from a trace to 2 per cent in foundry iron. Much has been written concerning the injurious effect of sulphur in iron. Since manganese neutralizes the effect by combining with it in the form of manganese sulphide which passes off in slag, it is the usual practice when determining the suitability of an iron for any specific purpose, to consider the proportion of manganese in connection with the sulphur content. It generally is understood that irons high in sulphur call for a high proportion of manganese, and the equilibrium is considered established with 10 parts of manganese to one part of sulphur.

Manganese, when added to iron low sulphur, tends to harden the metal as it retards the separation of the graphite With irons high in sulphur, manganese may act as a softner by combining with and reducing the sulphur. Due to its hardness, iron high in manganese sometime is advocated for castings where good wearing properties are required. However, some authorities differ, stating that the crystals in such iron are brittle which break off in the form of grit and spread under the work resulting in poor wearing properties. These authorities agree that it is a mistake to destroy the beneficial effects of sulphur by the introduction of large quantities of manganese. They state that the general properties of cast iron are not materially affected when the manganese does not exceed 0.7 per cent.

Opinions Differ on Sulphur

Recently many foundrymen have changed their opinion regarding the effect of sulphur in castings, especially where the castings are required to have good wearing qualities when used under heated conditions. Formerly all troubles were attributed to sulphur, whereas sulphur now is considered highly desirable for certain types of castings when strength and wearing properties are desired, the sulpher content being permissable to 0.12 per cent for cylinder work. Sulphur reduces the fluidity of iron, makes it harder, and since all hard irons cool quickly, it is necessary to pour the metal as hot as possible. Sulphur is not desirable for light castings made in green sand and should be eliminated as far as passible.

Consideration of phosphorus is necessary in connection with a study of foundry iron. Phosphorus adds fluidity to the iron and its proportion varies little on remelting. A difference of opinion exists among foundrymen concerning phosphorus. Some advocate low phosphorus for internal combustion engine cylinders, whereas Mr. Cook states that phosphorus may be used up to 1 per cent as long as the equilibrium of silicon and carbon is correct for that type of work. The writer has found that high phosphorus tends to make heavy castings draw, especially at the places were two or more walls of the metal join.

This discussion shows in a measure the diversity of opinion existing regarding the effect of the different constituents in iron and displays the lack

of knowledge on the scientific control of foundry iron. The question of establishing standards for different types of castings now is being undertaken by the Cast Iron Research associations of various countries. The standardization of such mixtures is overdue and the working out of the problem will involve an emense amount of investigation. Foundrymen are waiting for information of a definite character, stated in plain language, which will give results at least approximately correct. The type of information desired is along the lines embodied in the accompanying table, presented by William A. Bole before the Pittsburgh Foundrymen's association several years ago and refere to the composition of iron for general castings varying from ¼ to 3 inches in thickness.

Castings Handled on Gravity Carriers

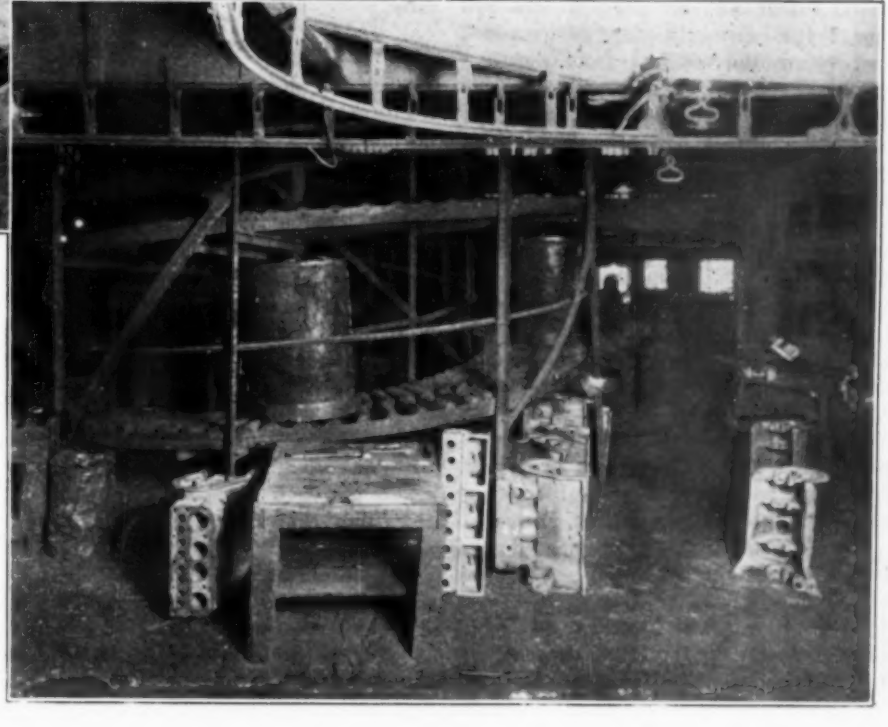
GRAVITY conveying systems, used successfully in many industries, find application in the foundry field. One type of such an installation is in service at the plant of the Allyne-Ryan Foundry Co., Cleveland, where a carrier, built by the Mathews Conveyor Co., Elmwood City, Pa., is employed to transport castings from the grinding department to the shipping room.

The Allyne-Ryan company produces gray iron castings for a number of automobile manufacturers. The castings are cleaned in the foundry cleaning room, and then are taken upstairs to the grinders. After the rough spots are ground off, those which weigh less than 50 pounds are thrown upon a power conveyor which carries them to the sorters.

The sorters place like castings in steel barrels and steel-bound wood boxes and start the loaded containers down the gravity carrier to the shipping room. The carrier ends at the shipping room scales where the castings are weighed and counted before shipping. The empty containers are trucked back to the mill-room by the same men that take the large castings to the shipping room. In this way no extra cost is involved in returning the containers to the grinding room.

The grinding room is located on the floor above the shipping room. Two lines of gravity carriers are placed beside the sorting tables, one being about 50 and the other 30 feet long. Both lines lead to the main gravity carrier which takes the castings out of the grinding room. The containers are loaded on these two sections and started to the shipping room. After traveling about 50 feet, the container reaches a spiral conveyor. In two turns the containers are lowered one half the distance to the shipping room floor.

The containers then roll over another straight section for about 50 feet and come to a second roller spiral which lowers them to the shipping room floor. A section on the floor carries the containers to the scales. Including the spirals, 300 feet of roller carrier is used in the installation. The carrier consists of double rows of 3¼-inch ball bearing rollers 14 inches long, making the complete width about 30 inches.



ABOVE—CASTINGS ARE TAKEN TO THE SHIPPING ROOM IN STEEL BARRELS OVER ROLLER CONVEYORS. BELOW—THE CONTAINERS ARE LOWERED TO THE FIRST FLOOR ON TWO SPIRALS

A foundry recently has been completed for the Pacific Faucet Mfg. Co., Los Angeles, Cal., manufacturers of faucets and fittings for the plumbing trade. This company is incorporated for $100,000 with the following officers: Myron J. Glauber, president and general manager, Emma F. Glauber-Black, vice president and treasurer, William J. Black, secretary, and Ted Lederer, assistant secretary.

Note Defects In Cast Bronze

Discuss Melting Temperatures, Mixtures, Deoxidizers and Their Relative Applications Best Suited To Eliminate the Defects Which Usually Occur In Producing Cast Brasses and Bronzes

BY R. L. BINNEY and N. I. TERBILLE

IN RECENT years numerous articles have been written on the causes and correction of defects found in bronze castings. The subject is broad and considerable space would be required to touch even lightly on the majority of the troubles experienced by the makers of red brasses. Difficulties that are due to molding practice, namely blowholes, trapped dirt, improper gating, etc., will not be discussed here, but attention will be directed to the proper melting practices.

There are probably few foundrymen, who at some time or other have not been annoyed with aeration, oxidation, poor structures, cold shuts and related troubles. In this article the nature of the charge or rather the conditions of the metal to be melted, the type of furnace in which the metal is to be melted and melting practice will be considered.

Some years ago the belief was common that only virgin metals could be employed for first class castings. However, in recent years a great many tests have been made and much data gathered that show castings made by melting only virgin metals have no better physical properties than those made with 50 per cent scrap. When a nonferrous charge is weighed, the copper, and the gates or the scrap castings form the initial charge and the pig tin, lead and zinc should form the mix, to be added just before the removal from the furnace. The order in which the elements are added and the method of adding them is also important. The exact procedure depends upon the type of furnace. If the melting is done in a crucible the form and order in which they are added is of little consequence because the total amount is small and the exposed surface is not great. In this case, it is simply necessary to add the correct amount and pole thoroughly. In the open flame type of furnace where the exposed surface is large the tin, zinc or lead should be added in the order named and in small pigs by throwing them in different parts of the furnace and thoroughly poling.

The faster a metal is melted the better it will be from an economical and metallurgical point of view. Therefore, it is advisable to have the furnace heated to a high temperature before adding the copper and the scrap. The metal then should be covered with a thin layer of some protective material, as for example, borax. This will prevent volatilization and oxidation. It is not within the scope of this paper to discuss the relative merits of the different types of furnaces such as the crucible furnace, the electric furnace, and the open flame furnace.

The recent articles that have been prepared by well versed writers claim the type of furnace has nothing to do with the troubles discussed here and the evidence seems to be in their favor. However, the method of handling the metal does influence the final product and, therefore, it is suggested in the cases where the exposed area is large, the covering will have a real value. From experience, many of the difficulties attributed to the melting department are produced by the condition of the refractories. The furnace should be seasoned thoroughly before the first melting as new linings are detrimental. A heat or two should be melted in any newly lined furnace and the metal run into ingots to prevent aeration and oxidation. In order to prove this take two pouring pots, one well seasoned and the other green and break the castings obtained from the two pots and note fractures carefully.

Note Different Fractures

The fracture of the metal poured from the seasoned pot will have the normal appearance of a good casting. There will be no small shiny spots about the size of a pin point or larger, nor will there be brownish streaks or various colored spots. Now obtain clean fracture of the casting poured from the green pot. Upon careful examination under a lense giving 10-20 diameters, small holes will be observed which have a bright shiny surface. In many cases spots or streaks will be noted appearing from a yellow to a dark brown. The presence of oxide and aeration are detrimental to a casting that must have a high tensile strength, and those required to resist internal pressure or where the surface is to be machined with no flaws or defects remaining after machining. It is true that either one or both of these defects may be present. It is also possible with certain alloys that cast at lower temperature that neither trouble will appear, but in general the statement holds true that green linings in a furnace or pot should never be used.

The borax which was suggested is not to be considered in the light of a flux. The use of a deoxidizer is recommended. Phosphor copper serves admirably for this purpose, at least for the ordinary bronzes whose average analysis is represented by 85-5-5-5. The amount of phosphor copper to be added is dependent upon the nature of the castings. It may be used strictly as a deoxidizer only, in which case only a trace of the phosphorus appears in the finished casting or it may be used to impart hardness to the metal. The use of phosphor copper should be under careful observation. Many old timers insist upon guessing on the amount, which they may be able to handle correctly, but it is extremely bad practice as probably the majority of their assistants will not be able to gage it correctly. In the cases where the phosphor copper is not used to impart physical properties, due to its presence in the casting by forming the eutectic Cu3P and Cu. ⅛ to ¼ pound of the 15 per cent phosphor copper per 100 pounds of metal is sufficient. A small part is added at the bottom of the pot or furnace when it is originally charged. The remainder consisting of ½ to 2/3 of the total amount is added after the metal is melted, skimmed and just prior to pouring. Then, it must be thoroughly poled that it may best do its work. The metal should be covered immediately with charcoal after the introduction of the phosphor copper. The phosphorus makes the metal more fluid and as a result the casting temperature may be somewhat lowered.

Phosphorus, in the form of phosphor tin or phosphor copper, magnesium, boron, silicon, zinc, and aluminum, in yellow brass only, are true deoxidizers and comply with the requirements in-so-far as they have a greater affinity for oxygen than the metals to which they are added. Hence, when a deoxidizer is added to the metal just before casting and the mixture thoroughly poled the oxides are

reduced and a better metal results. Melting always should be done under the most careful supervision and no foundryman should rely entirely on cleaning agents. The deoxidizer should be used only to free the metal from the unavoidable oxidation as the damage done by careless melting often is incompletely remedied by deoxidizers. It is well to point out here that one must not confuse the use of the two terms flux and deoxidizer. Flux is an agent added to the charge to protect the metal from furnace atmosphere, to make it more fluid when cast and to purge it of dirt.

Correct Melting Temperatures

One of the most important features of good foundry practice is the correct determination of melting temperatures. This is probably quite a difficult problem. Nevertheless, it is one well worth careful study by every producer of nonferrous castings. Formulate certain rules which will govern all the cases. This will prevent well-meaning, but not well-informed individuals from exercising too much control. The size of the casting and the thickness of the walls are important considerations, but in one's own shop where the general run of the work can be classified, definite limits may be established for these temperatures. One excellent rule to follow is that the lower the temperature at which the castings can be made successfully, the better the resulting product. This may be demonstrated to the men and often is a means for securing co-operation on this point. Metal that is poured at the lower temperatures has a fine dense grain and if handled properly will be free from oxide and air holes. The fractures of metals melted at a higher temperature show a coarse structure. The physical properties will be less desirable than those of the same metal cast at a lower temperature. The amount of scrap that is produced in any foundry due to the improper temperature is probably large. Not only is the scrap reduced and the physical properties improved but the time of melting and the fuel consumption also are reduced. The cost of the necessary pyrometer outfit is soon saved and the investment pays a handsome dividend. If the temperature is too low, cold shuts will result which, of course, raise the scrap percentage. It is doubtful if the loss due to this cause is great and certainly there is no excuse for it as the difficulty is a simple one and after a few experiments the lowest temperature at which the alloy will pour may be decided upon.

In case a foundryman is not familiar with temperature work, a few approximate limits to help locate the proper temperature will be suggested. For an alloy represented by 90, copper; 10, tin a temperature of 2100 degrees Fahr. is a good starting point. If thin sections are required, it may take 2200 degrees Fahr. The mixture 85, copper; 5, tin; 5, lead; 5, zinc should cast well from 2000 to 2050 degrees Fahr. These temperatures consider that the metal has been deoxidized by phosphor copper. In cases where a deoxidizer is not used, it probably will increase the pouring temperature 50 to 100 degrees Fahr. However, this would not be good practice. For the plastic bronzes or high lead alloys 1900 degrees Fahr. is a good starting point. Some foundries cast bronzes at 2400 degrees. However, this is bad practice, and the resulting castings are of an inferior grade.

Improper mixtures and the introduction of impurities in the mixtures are causes of difficulties in some shops not under laboratory control. Improper mixtures produce alloys that are not within the specified limits as given by the buyer; or mixtures resulting from the use of foreign scrap, the analysis of which is not known. Where the material is bought on specification the product should be analyzed to make sure that the desired combination is obtained. In cases where materials are melted, the analyses of which are not known, improper mixtures usually result, and the resulting castings do not have the required chemical and physical properties. For example it would be unnecessary to produce a high tin and low lead mixture for castings requiring little strength but good machineability. On the other hand a bronze mixture to give high physical properties in the casting may be relatively low in tin and copper but high in lead and zinc, thus giving an undesirable alloy. The introduction of impurities in standard mixtures cause trouble in the shops as they effect the machineability and physical properties of the castings. Iron, antimony, phosphorus, nickel, aluminum, manganese, and sulphur are among some of the impurities that have marked effect upon the castings. A small amount of such impurities are only necessary to completely change the nature of the metal. In small shops not under technical control a piece of scrap weighing but a few pounds might introduce enough impurity to spoil not only one heat, but spread into several when the gates in succeeding mixtures are remelted.

Improper gating has received a great deal of attention and several firms attempting to lower their casting temperatures to improve their product have reported that the idea is fallacious. Upon careful investigation of the specific cases that have been brought to our attention, it has been proven that the trouble was due to the fact the gates were so constructed, that hot metal was necessary. This, however, does not prove the colder metal is not better but it did show a faulty gating practice.

In order to establish the correct temperature at which castings should be made it is well to have same specific standard of reference. Since the casting temperature varies by several hundreds of degrees it is not advisable to give any definite figure but to state that cases requiring a temperature above 2200 degrees Fahr. are quite rare.

Compare Various Fractures

If the general run of castings are about the same size or if some definite product is being cast on a quantity basis it is easy to issue suitable rules to the melter and properly applied after proper experiments have been made. To do this a few molds should be made up and cast at different temperatures. When the castings are cleaned and tagged, showing the temperatures at which they were cast, the castings should then be broken cold and the fractures carefully noted. There will be a decided difference in the appearance of the two extremes. If it is possible select the one that is just beginning to have cold shuts. This fracture should be taken as a reference standard. It may not be advisable to cast quite as low as the temperature here designated, yet the appearance of the fracture will be that toward which the other castings should approach. After this has been done the foundry foreman should be shown sample fractures of the castings from time to time so that he may ascertain the correct temperatures to use in melting. The metal cast at the low temperature will show a fine grain structure that is dense and if properly handled there will be no oxide or aeration present. The sample cast at the high temperature will show a coarse structure and by using a good standard magnifying glass, will show cracks and fissures running through the metal where the metal has drawn away from itself or cracked internally upon solidification. The castings may appear very similar on the outside and when fractured show a skin effect or dark coloring varying in depth. This shell-like effect on parts of the casting is due to the fact that the surface quickly solidified upon contact with the mold. Different specimens should

be polished and etched for microscopic examination. This will prove interesting, as it will be possible to see the difference in the structures. A piece of metal that has been cast at a very high temperature should be polished and etched and then placed on a very fine polisher until the etching has been removed. The appearance will then reveal the cracks removed from the outer surface that are due to the internal strains set up by the metal on solidification.

After examining a great many castings, the authors have observed that the tendency for occluded gases and oxides is much greater at high temperatures. It can be readily seen why the physical properties of pieces of metal of exactly the same chemical analysis should be vastly different. The tensile strength and the hardness are different and the appearance of the fractures so dissimilar that it is difficult to believe they are the same metal. Yet we have seen samples under these conditions vary 10,000 to 15,000 pounds per square inch in their tensile strength. When castings are required to stand internal pressure they must be free of internal cracks. It would be difficult to pick out any single cause having greater influence on the final product than that of the casting temperature.

Metals at high temperatures have a natural affinity for oxygen, and it is only natural to expect a greater degree of oxidation in castings made at the upper limits. The higher temperatures are also undesirable due to the fact that more fuel is consumed, furnaces and pouring pots deteriorate more rapidly, zinc volatilizes, castings develop finns and excessive time is required in the melting.

After examining a number of castings made in this country and abroad, it seems that the greatest number of defects found is due to the higher temperatures used in melting metals and alloys. Castings exhibiting oxides ofttimes show good fracture, and structure. The majority of such troubles were due to a combination of faulty melting practices and pouring at incorrect temperature with greater emphasis on the latter. This is a subject well worth careful consideration of all nonferrous founders.

How and Why in Brass Founding

By Charles Vickers

Cores Hard To Remove

We are making bronze castings weighing from 1000 *to* 7000 *pounds, and at times the metal will eat into the cores and considerable time is spent cleaning the castings. The mixture is copper* 75 *per cent; tin,* 10 *per cent, lead* 15 *per cent. We use for cores two parts beach sand to one of Albany sand and we have tried various kinds of core washes. It seems to the writer the trouble may be in the sand, and we want to learn if in your opinion a mixture of two parts of beach sand to one part of Albany is the proper mixture for such castings.*

If the metal blows and scabs against the core surfaces, then the mixture is at fault, being of too fine a grain. If, however, the metal lays quietly and the only difficulty is penetration, then the core sand is suitable; the size of the grain of the beach and molding sands will determine this point. For castings of the weight stated a coarse sand should be used. The molding sand should be coarse and sticky by nature and if too much is used the cores will bake hard into the castings and be removed with difficulty. The alloy mentioned is searching in nature as it sinks into the sand and naturally the mixed mass of metal and sand is extremely difficult to clean away. Sometimes, when phosphorus is used in the metal, it is impossible to remove the core. To prevent this seeping into the cores the following wash was devised by Mr. Joseph McGinnis of the Eastwood Wire Mfg. Co., Belleville, N. J. Take one part of water glass (silicate of soda) 4 parts of water and 4 parts of Dixons No. 2441 facing. Put half the water and all the facing in a bucket and mix thoroughly, (it may be necessary to do this with the hands, squeezing it through the fingers). When this is done, mix the water glass with the remaining water, and add this to the facing and water. This makes a fairly thin wash which is painted on the cores; castings for impellers and important parts should be given two or more coats; each coat being dried before the next one is applied.

We suggest the use of the above core wash for the castings in question and we feel confident the castings will come out smooth inside, thus eliminating all the labor of cleaning now necessary.

Plating Aluminum

We have a call for an aluminum casting that can be either gold or silver plated. Are there such alloys of aluminum that can be plated while in the form of castings. If so kindly let us know, giving price.

We understand that aluminum has been plated, both in the cast and the wrought forms. However, it is a difficult operation, and demands more than usual skill on the part of the plater. It is doubtful if there would be the slightest difference between the various alloys in regard to the ease with which they could be plated. We suggest the castings be made using the ordinary No. 12 aluminum alloy after a conference with the plater makes it advisable to go ahead with them.

Making Brass Bushings

We wish to know of a bronze formula suitable for bearings and bushing stock, also for making acid resisting bronze castings. In addition we want a formula for a good bronze that may be made by using up old valves, etc. This must be a good metal of high tensile strength.

A formula suitable for the bearings, bushings, acid resisting castings is as follows:

BEARINGS, BUSHINGS AND ACID RESISTING CASTINGS

	Per cent
Copper	78
Tin	15
Zinc	7

A formula of high tensile strength is as follows:

HIGH TENSILE STRENGTH ALLOY

	Per cent
Copper	88
Tin	10
Zinc	2

To make this out of old valves and miscellaneous scrap metal, first melt down and ingot the scrap, take drillings from every heat of the ingots and mix them thoroughly, and send to a chemist for analysis. Knowing exactly what is in the remelted o'd valves, etc., the ingot may be melted with enough copper and tin and zinc to bring the alloy to the desired formula.

As the old valves, etc., may contain several per cent of zinc and the high grade alloy only 2 per cent, the percentage of new metals in the admixture

for 88-10-2 probably will be greater than the amount of scrap that may be used. Unless this scrap is much superior to the general run of such scrap, the final 88-10-2 alloy castings will about equal common, ordinary red metal in tensile strength. Alloys of high tensile strength cannot be made by the use of scrap in ordinary brass melting furnaces. If a high tensile alloy really is wanted, melt 90 pounds of good electrolytic copper under charcoal, first putting in the crucibles 1½ ounces of phosphor copper containing 15 per cent phosphorus. When thoroughly fluid add 2 pounds zinc, 1½ pounds lead and 6½ pounds of tin.

Metal Should Be Clean

We have experienced trouble in making bushings and we send you a sample to form your judgment thereof. The metal is composed of 44 pounds copper, 6 pounds tin and 150 pounds of our own gates from bushings and purchased scrap bearings. We have used this mixture for about a year with success. The liquid metal has a thick skin on top and does not have the clear appearance we desire.

The metal contains iron and aluminum as determined by analysis and it also contains a large amount of the oxides of the various metals of which it is composed. It is the result of melting together a lot of miscellaneous junk under the mistaken impression that it is cheaper than buying reliable ingot, or even brand new metals in most cases. Clean scrap metals may, of course, be used when obtainable, but the brass founder should let the junk go to the smelter, as the two businesses cannot be combined with profit, and the smelter who does not know how to remove the harmful impurities from the metal, may get the information by paying for it.

In this case the thick metal may be reduced by the addition of common salt, but after all that is possible is done in the foundry, the chances are against getting castings that will not be filled with holes or with dross, or with hard spots, or some other defect that will condemn them to the scrap heap. It will make no difference whether the melting is done in coke-fired, coal-fired, gas-fired, oil-fired, or electric furnaces the castings will be bad when the metal is bad. Metals, like all living things, revert to the soil from which they came, they deteriorate and after a time have to pass again through refining processes that rid them of the dross and impurities they have picked up during their *life*. The easiest way to work will be to sell this scrap and start over with better metal.

Change Composition

We have experienced here in China some difficulty casting a bronze valve used on a blast furnace. The casting weighs approximately 800 pounds, the alloy used being copper 95 per cent, tin 5 per cent, and to which is added one per cent phosphor copper. In spite of all the care we take the castings usually leak under a pressure of 80 pounds per square inch, and the trouble seems due to a comparatively few pinholes. The copper has to be melted in a 32-inch cupola from which it is tapped into a ladle containing the molten tin and phosphor copper. Formerly we poured metal into a second ladle, using the two ladles at the mold side, but we found this pouring from one ladle to another so chilled the metal the castings came with cold shuts. We now pour from one ladle using one sprue, but the results were not satisfactory. Therefore, we added 6 ounces of aluminum, the effect of which was shown in smoother castings, but the leaking still persisted. The molds are of dry sand and the cores are dead burned, so we are of the opinion the molding is not at fault in this particular case.

While the mold may be properly made as far as grade of sand and the density to which it is rammed is concerned, there is every likelihood the system of gates is wrong. A large and thin casting, run over a core is easily spoilt by insufficient gating. If the metal has to run so far within the mold, it barely flows to its destination, the casting will leak under pressure at the places covered with the metal that was cool and sluggish.

It is imperative to distribute the gates so that the metal will not be dull and sluggish when it reaches the termination of its flow, which may be the confines of the mold, or a junction with the metal from another gate. The mold also has to be filled quickly and uniformly with metal of uniform temperature. Therefore, the first step should be to study the pattern. If one of the defective castings is available considerable information may be gleaned from it, for it is likely there will be seams where streams of metal have met and united imperfectly. Decide on the number of pouring sprues to be used. Each one should be of not more than 1-inch diameter if set outside the casting. Connect each sprue to its own set of gates. In pouring the mold, it is not necessary, nor advisable to use as many ladles as there are sprues; one ladle is all that is required.

There are two methods available to facilitate pouring. One is to place a runner box on top of the cope large enough to enclose all the sprues. When this method is used it is necessary to adopt means that will make it possible to fill entirely the pouring basin before any metal is permitted to enter the sprues. This is effected by putting a plug in the mouth of each sprue. When the basin is filled, every plug is lifted simultaneously. Meanwhile the basin is kept filled from the ladle. These plugs are made in little coreboxes. They are conical in shape, and are made to fit into small slab cores carrying a round conical hole. They are fitted over the top of each sprue, before the runner box is rammed up. Each plug is carried on the end of a long thin bolt, the head of which is bedded within the core, and the other end bent to a loop for convenience in lifting it away after the basin is filled. The alloy should be hot enough to be freely liquid when poured.

The second method involves the use of two copes The regular cope has the sprues carried flush to the top and connected together by a system of gates. The extra cope, which merely is a covering cope, has a flat surface and carries the sprue topped with basin and plug down which the metal goes to fill the system of gates and sprues and lower gates to the casting. Such a mold has to be very strongly bound together, or secured, otherwise the copes will be lifted by the pressure of the metal.

Cores Are Too Hard

We make large numbers of bronze bushings about 1⅛ inches long, 1 inch diameter and having a core ⅜-inch diameter. The cores are so hard we have difficulty in removing them from the castings, and are obliged to ream them out. We use a mixture of sea sand 60 parts, core oil 1 part. Can you suggest a better mixture of sand and binder for making the cores?

By decreasing the amount of binder the cores will come softer, and if dipped in a plumbago wash of creamy consistency, the metal will not eat into the core. If it is desirable to change the core mixture, the following makes a good core:

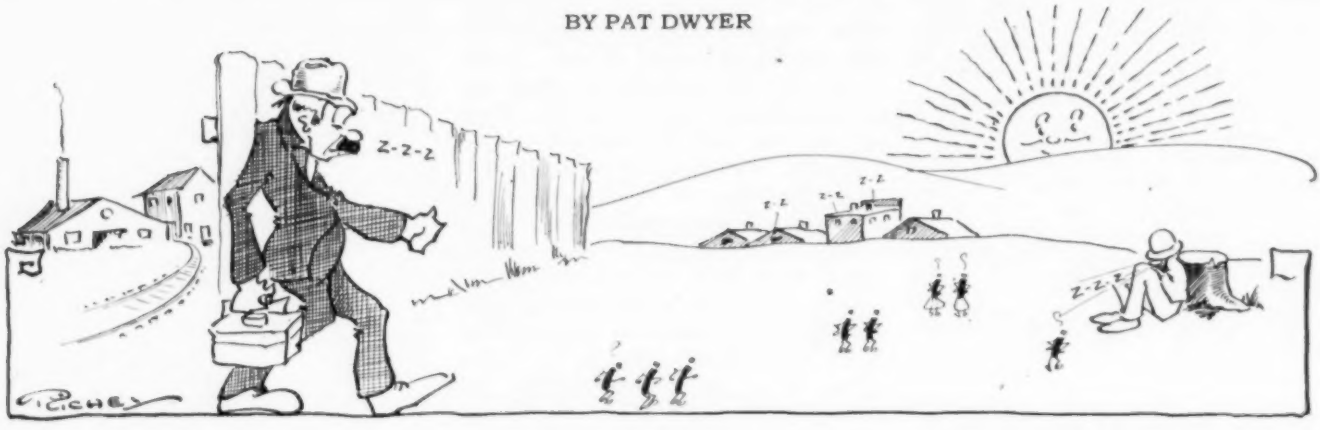
CORE MIXTURE

	Pounds
Sharp sand.....	30
New Molding Sand....	10
Powdered rosin.....	2

Have the sands thoroughly dry, mix with the rosin, then water to proper dampness. Bake the cores until the rosin melts and smokes, when cold the core will be strong, but it is easily removed; if found too strong for this particular job, simply decrease the percentage of rosin.

Bill on How and Why Molds Are Stacked—III

BY PAT DWYER



REALLY I could not say offhand how many times I have read descriptions of the manner in which rosy-fingered Dawn has pushed aside the sable curtains of darkness and peeped forth to view a world rejuvenated under the refreshing and sparkling dews of the night. From these descriptions, I have gathered in a general way that dawn is heralded by giant spears of light that gradually appear in the East and continue to grow brighter for at least a full page before the sun finally emerges from the sea or from behind the mountain or from any other place that may meet the approval of the author. Of course some authors turn out a more complete job than others. For example, Joseph Conrad thinks nothing of devoting a whole chapter to the stupendous task of lifting the sun, dripping, halfway above the rim of the sea on the far horizon. He employs a full orchestra and starts the symphony with a gentle movement of the strings. It is repeated on the reeds with variations and then taken up pianissimo by the brass. He repeats the whole movement two or three times, but introduces a few new figures and a different combination of instruments on each occasion. The 'cello and the *B* flat bass get in some nifty licks on the last time through. In the concluding page of the chapter he steps on the gas in good shape and with a long sustained note on the cornets, a crescendo roll on the snare drum and a final bang on the big drum he rolls the sun out of its hiding place full into the center of the stage. Contrast the foregoing with the crisp, snappy style affected by the gentleman who entertained us in by gone years with the classic details of the adventures of Buffalo Bill and his merry men while they roamed the hills and valleys and the great open spaces of the West. No effeminate tommyrot for him. He set down events connected with the raw, red life of the old frontier as they probably never were and certainly never will be again. The sun shot like a ball of fire above the canyon wall and the instant the hero's eyes lighted on the sights of his Winchester he popped off a few leading Indians, stampeded the whole herd of ponies and then dashed through the remainder of the tribe like the devil went through Athlone, in standing jumps.

All my knowledge of the subject has not been gleaned from the printed page. To be strictly truthful I must admit that I actually have seen the sun rise on a few occasions, but the circumstances surrounding the phenomenon each time have been of a character that prevented me from dawdling by the wayside to admire it. Properly to appreciate the beauties of nature one must be in a receptive mood and this happy condition only obtains when one is warm and comfortable and properly distended at the waist line.

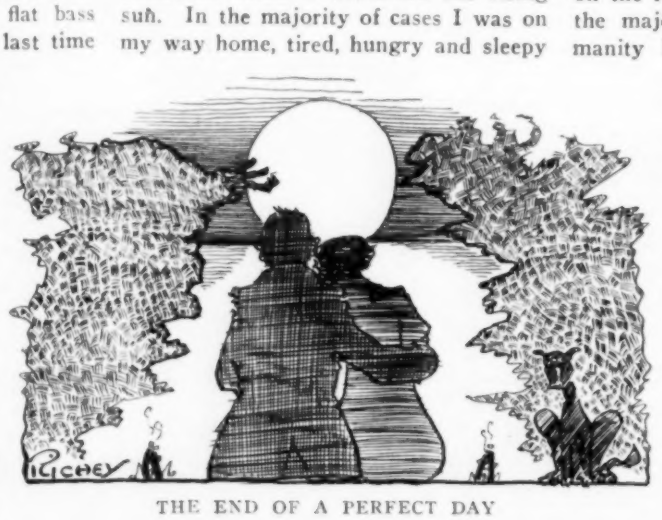
None of these favorable factors happened to be in evidence on the various occasions when I witnessed the rising sun. In the majority of cases I was on my way home, tired, hungry and sleepy after putting in an extra shift trying to hustle break-down jobs through a steel foundry. The prospect of hurrying home, grabbing a bite of breakfast and rushing back to another long day's grind is not conducive to that particular frame of mind which enables a man to appreciate the sunrise.

The phenomenon meant no more to me than the sight of Niagara Falls meant to the lad who stood one day on Prospect point gazing down on the flood of rushing waters. A gushing old lady by his side asked him if he did not think it wonderful. "What do you mean, wonderful?" said he, "Why," she came back in awe struck tones, "Just think of the immense volume of water that has been falling here continuously for millions of years and that in all probability will continue to fall until time is no more."

The lad looked at her pityingly. "Well," says he, "Why should it not fall. What's to stop it?"

Just so. Whats to stop it? The sun rises every day in the year and so far as I can see no justification exists for going into raptures over it.

Many forms of pleasure are grouped on the forbidden list. In common with the majority of poor, weak-kneed humanity I have on occasion ventured within the prescribed area, sometimes through natural inclination and at other times on account of that peculiar spirit of perversity which leads us to believe that stolen fruits are sweetest. I may be a pagan in some respects, but I am no sun worshipper. I entertain radically different views in regard to the moon. I have seen it by day and night, on sea and land at every season of the year, rising and setting and in every stage of progress between. I have taken little interest in

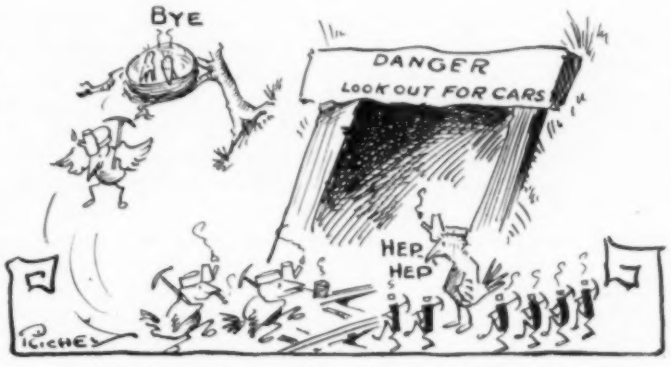


THE END OF A PERFECT DAY

it in recent years, but there was a time —Oh! Well, you probably have been silly yourself at one period of your existence. Silly and happy. You have walked slowly, oh so slowly, down the old moon bathed country road with HER by your side and tried to muster up sufficient courage to take her dear little hand, hanging by her side so temptingly and so close. Maybe you did accidentally find her hand in yours and experienced the electric thrill that comes only once in a lifetime. With your kind permission I'll leave you there hand in hand, walking on air and return to the subject of suns and sunrises. Many a time this summer I have been tempted to rise at daybreak, but the temptation has not been due to any desire to see the sun rise or to go prowling over the lawn in my bare feet to exclaim in raptures over the beauties of nature. Nothing but a deep rooted aversion to leaving my downy couch before the proper time has prevented me from sallying forth with a blunderbuss loaded with slugs and murdering one of the descendants of the famous original Cock Robin.

Early in the summer a pair of those impudent birds built a nest in a big tree in front of the house. Had they confined their efforts to the legitimate duties connected with raising and feeding a family, I should not even think of registering a complaint of any kind. If they chose to rise at daybreak to start the day's work I should consider them well within their rights even though I deplored their lack of judgment and rotten poor taste. I trust I am no more irritable or ferocious than the average citizen, but when a silly blighter of a red-vested robin climbs to the top of a tree outside my window and does absolutely nothing but whistle for about two hours, I leave it to you if I am not justified in wanting to fill his little red waistcoat with a handful of slugs, or failing that, to tap him on the knob with a hammer.

I always have had my suspicion of authors who have gone into raptures over "Our Feathered Friends." If they had to lie awake from 4 to 6 o'clock every morning listening to one of these precious friends repeating the same half dozen notes over and over I am sure that instead of indulging in honeyed phrases they would hurl a flock of bootjacks out through the window.



THEY JOIN THE RANKS OF THE LIGHT BRIGADE

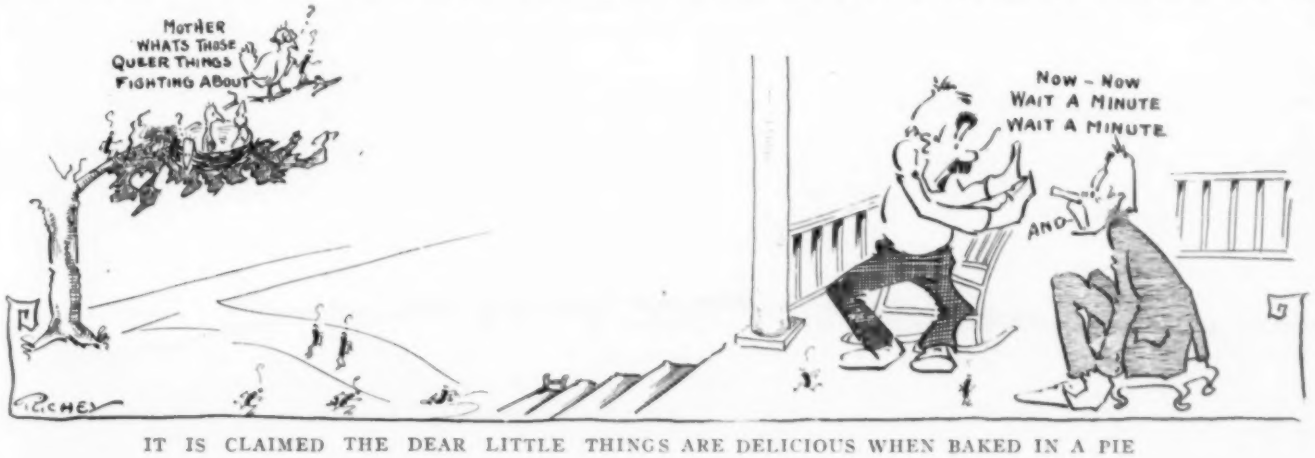
One night recently while Bill was sitting on the veranda I directed his attention to the robin's nest which by this time contained four indecently naked young squawkers. I asked him if he thought I would be justified in blowing up the entire outfit with a stick of dynamite on account of the manner in which the father disturbed my morning's rest. He evaded the question by a description of an experience he had last summer. I can't say that I accepted it in its entirety, but I am passing it along for what it is worth.

"Have I ever told you" said he of the robins they have down East? "They—the robins—don't seem to care where they build their nests. One day last summer I accompanied the manager and a few other citizens on a tour of inspection around the bank head of a coal mine and while proceeding up the incline that led to the tipple we discovered a robin's nest in among the timbers that supported the rails. The mother bird was sitting calmly on the eggs and I expressed surprise that she should choose such a place under the constant rumble of the coal buggies passing up and down and in a sooty atmosphere impregnated with coal dust.

"I was assured solemnly that the birds had built there for several years and the most extraordinary feature of the case was that when the young birds were hatched each one was as black as coal and each one bore on his head a little black cap with a minature miner's lamp stuck in the front of it! I left that part of the country before the birds were hatched and therefore I cannot vouch for the story, but the man who related it to me is the chief engineer of an important coal mining company and you know an engineer's training and experience tends to make him conservative in his statements. I have met a few exceptions. However, the foregoing just goes to show that men are not the only creatures who can adapt themselves to circumstances. It is a daily experience with foundrymen. Consider for a moment the manner in which molds are stacked, a subject I have touched upon briefly on a former occasion.

"The third method of stacking molds is practiced to a considerable extent in steel foundries where all the metal is handled in bottom-pour ladles. The principal object to be attained in this instance is to minimize the number of times the nozzle has to be opened and closed. Pouring a ladle full of steel into one large mold or into a number of fairly large molds, an operation that does not consume more than 15 to 20 minutes, is one thing. Holding the ladle for an hour or an hour and a half while pouring 100 or more small molds is something else altogether.

"In the first instance the stream of steel is only stopped a few times and in each case the volume of steel flowing through the nozzle keeps it at a high



IT IS CLAIMED THE DEAR LITTLE THINGS ARE DELICIOUS WHEN BAKED IN A PIE

temperature that prevents the metal from sticking. The dead metal, or metal that is cooling constantly on the bottom of the ladle, is cleaned out thoroughly at each tap and replaced with hot metal from the upper part of the ladle. In the second instance unless the metal is exceedingly hot when it is tapped, it will freeze several times in the nozzle before the ladle is emptied. This condition necessitates the use of a *pricker* with its tendency toward accidents of various kinds. The metal may splash and burn the operator. Sometimes when the *cork* is pushed up into the nozzle, the upper end splinters or displaces the graphite stopper on the lower end of the stopper rod. The result usually is a leaking stopper for the remainder of the heat.

"Molten steel is spilled over the tops of the flasks as the ladle is conveyed by the crane from flask to flask. The steel sticks to the gaggers, the bars, the flanges of the flask, the handles, and the guide pins. Even under the most favorable circumstances a steel foundry is no garden of delight, but after a floor of molds has been poured with a leaking stopper, the sight is enough to make an angel weep.

"So far as I know few foundrymen have attained to the angelic state or standard. They do not weep. Neither do they express their emotion in silent grief. No indeed. Silence is furthest from their thoughts. They are no silver screen artists capable of expressing the most intense emotion—any emotion—by the simple expedient of stretching their eyelids to their elastic limit, and by supplementing this performance by doing an imitation of a duck trying to swallow a raw potato.

"These foundry birds are great believers in the efficacy of the spoken word. The ladleman tells the melter he should get himself to job brewing gruel in a home for aged and indigent ladies. The melter comes back with a snappy rejoinder to the effect that all the ladleman needs is a tin cup, a cane or a pair of crutches, and a half starved looking dog to lead him around. He also calls on high heaven to witness that when he tapped the steel into the ladle it was hot enough to pour cambric needles; but no steel that ever was melted could stay hot forever in the hands of a man who apparently took time to repeat one of the psalms each time before he lifted the stopper.

"The foregoing merely outlines in a general way the character of the dialog. I cannot give the exact words because they are not listed in Mr. Webster's well known treatise on the subject of words and their meanings. Also because they vary, depending on the originality of the actor and his degree of familiarity with words and phrases designed primarily for emergency use.

"Within recent years the oxyacetylene torch has been adapted for use in relieving frozen nozzles and has eliminated many of the unpleasant features incident to this condition. A piece of ¾ or 1-inch steel pipe 10 feet long is attached at one end to the rubber hose leading to the gas tank or the gas main. The other end for 12 or 15 inches is bent at a right angle so that the entire device corresponds in shape to the ordinary *pricker*. The end terminates in the usual tip and is introduced into the lower end of the nozzle. The flame from the tip melts the steel *cork* out of the nozzle and provides a clean passageway for the stream of metal when the stopper once more is lifted."

"Wait a minute, Bill," I said. "Wait a minute. As you were, and all that jolly old bunk. I wish you would stay on the broad high road. You start talking about stacking molds and then ramble off down a byway with a long handle torch in one hand looking for frozen nozzles. You may be able to find your way back, but I confess I am stranded high and dry. Kindly turn your engine over and let's get back in the fairway. In other words m'lad, start stacking your b'inkin' old molds before the next heat is ready to tap."

"My dear fried," said Bill, "You did the foundry business a service when you quit. If there is one thing more than another that requires careful reasoning from cause to effect, that one thing is the molder's trade. Apparently you have overlooked that trifling detail. If the nozzle of a bottom-pour ladle never became plugged, there would be little incentive to stack small molds. However, since the nozzle *does* become plugged occasionally, foundrymen have adopted the expedient of stacking small molds as a preventive measure. The ladle may be emptied quickly and the number of times the stopper is lifted is reduced to a minimum.

"If I simply had described how the molds are stacked you probably would have listened until I was through and then asked me to explain *why* they were stacked. I would have to go back to the beginning and go all over the same ground again. By explaining first why they are stacked we come logically to a description of how it is done. Old Tim Euclid laid the foundation of that method of reasoning over 2000 years ago and no person with the possible exception of our magazine story writers ever attempted to improve on it. These lads usually commence a story in the middle and then devote the remainder of the space at their disposal to an attempt, more or less successful, to straighten out the tangle.

"In this particular instance the molds are made in two-part flasks in the ordinary manner with the exception that the runner opening extends through both cope and drag. A bottom plate is placed on the first drag, that is the drag which forms the bottom of the stack of molds. No bottom plate is required on the succeeding drags. The stack of flasks is secured either by clamping each flask to the one immediately above, it or by employing long clamps that embrace the entire stack. Where the strain is not too great, a weight on top of the upper cope may be sufficient. Occasionally, where the molds are made in a snap flask it may be necessary to enclose the stack in a large flask and then ram sand in the space between the molds and the walls of the flask. Some foundrymen adopt another method. It is—"

"Never mind what it is" I said, "I am going to bed. I lose two hours sleep every morning—hours that probably I never shall be able to make up—listening to one robin. I have no intention of losing two more at night listening to a cuckoo talking about the foundry. Goo' night!"

Cudola Changes and Points on Operation

Question: I would like to know what grade of pig iron to purchase to make agricultural castings, using half scrap and half pig; also how to operate the cupola and whether limestone flux should be used.

Answer: Many foundries now have their iron anlyzed to be sure they are getting metal of the right composition. You should purchase pig iron which will give you a metal containing 2.0 to 2.3 per cent silicon, between 0.3 and 0.6 per cent phosphorus and between 0.5 and 0.7 per cent manganese. To get a metal of this mixture using half pig iron and half back scrap you would have to have pig iron which would average 2.5 per cent silicon, less than 0.05 per cent sulphur, 0.6 to 0.8 per cent manganese, and the same amount of phosphorus as you desire in the iron. The silicon and manganese must be higher in the pig iron than you expect to get in the casting as portions of these elements are burned out during the melting. On the other hand, sulphur which should not exceed 0.1 per cent in the casting, is absorbed from the coke, and the pig iron therefore should be lower in sulphur.

To charge the cupola, a wood fire should be built on the bottom and half of the coke in the bed should be charged into the cupola, then after a blue flame

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TYPICAL ANALYSES OF MISCELLANEOUS COMMODITIES USED IN FOUNDRY PRACTICE

By J. M. Quinn

(Continued from Data Sheet No. 534)

Commodity	Name Symbol	Zirconium Zr	Carbon C	Manganese Mn	Sulphur S	Phosphorus P	Silicon Si	Iron Fe	Aluminum Al	Copper Cu	Titanium Ti	Nickel Ni	Magnesium Mg	Source of Data	
ALLOYS—(Continued)															**ALLOYS—(Continued)**
Zirconium—Ferro		65.00	.....	.....	.....	.....	.....	26.00	7.70	.....	0.12	.....	.....	Foote Mineral Co., Philadelphia	1921
Zirconium—Ferro		35.00 40.00	.....	.....	.....	.....	16.00 18.00	.....	3.00 4.00	.....	.....	.....	.....	Metal & Thermit Corp., New York	1920
Zirconium—Ferro		30.00 40.00	Under 0.20	.....	.....	.....	8.00 12.00	30.00 40.00	5.00 8.00	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Zirconium—Ferro		39.33	0.15	.....	.....	.....	12.00	About 35.00	8.21	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
		Calcium Ca	C	Mn	S	P	Si	Fe	Al						
Calcium—Ferro Silicide		25.00 30.00	.....	.....	.....	.....	65.00 70.00	2.50	2.50	.....	.....	.....	.....	E. O. Friedman, Albany, N. Y.	1922
Calcium—Silicon, Grade No. 1		24.00 28.00	.....	.....	.....	.....	65.00 70.00	3.00 5.00	About 1.00	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Calcium—Silicon, Grade No. 2		18.00 22.00	.....	.....	.....	.....	55.00 60.00	15.00 20.00	About 1.00	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Magnesium—Manganese Silicon, No. 1		.....	Under 0.20	20.00 25.00	.....	.....	35.00 40.00	.....	.....	.....	.....	.....	25.00 30.00	Electro Metallurgical Sales Corp., New York	1922
Magnesium—Manganese Silicon, No. 2		.....	Under 0.20	27.00 33.00	.....	.....	40.00 50.00	.....	.....	.....	.....	.....	14.00 16.00	Electro Metallurgical Sales Corp., New York	1922
Magnesium—Manganese Silicon, No. 3		.....	Under 0.20	45.00 50.00	.....	.....	40.00 45.00	.....	.....	.....	.....	.....	8.00 10.00	Electro Metallurgical Sales Corp., New York	1922
Magnesium—Manganese Silicon		.....	.....	46.35	.....	.....	40.10	About 5.00	.....	.....	.....	.....	8.00	Electro Metallurgical Sales Corp., New York	1922
Nickel-Zirconium		30.00 35.00	Under 0.50	.....	.....	.....	8.00 12.00	5.00 10.00	5.00 8.00	.....	.....	32.00 38.00	.....	Electro Metallurgical Sales Corp., New York	1922
Nickel-Zirconium		31.64	.....	.....	.....	.....	10.07	About 5.00	10.14	.....	.....	43.20	.....	Electro Metallurgical Sales Corp., New York	1922
S-A-M Metal		.....	1.50	10.00 15.00	0.030	0.030	10.00 15.00	.....	5.00 7.00	.....	.....	.....	.....	G. B. Blackwell & Co., Ltd., Liverpool, England	1922
Silicon-Zirconium		30.00 40.00	Under 0.25	.....	.....	.....	45.00 50.00	10.00 20.00	.....	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Silicon-Zirconium		36.65	0.07	.....	.....	.....	48.74	About	.....	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Titanium 15% Ferro Carbon		.....	7.50	0.10	0.08	0.05	1.40	.....	0.80	.....	16.00	.....	.....	Titanium Alloy Mfg. Co., Niagara Falls, N. Y.	1920
Titanium 25% Carbon Free		.....	0.00	0.60	.....	.....	0.35	.....	5.75	.....	25.50	.....	.....	Metal & Thermit Corp., New York	1921
Zirconium—Ferro Silicon, No. 1		8.00 12.00	Under 0.10	.....	.....	.....	70.00 75.00	12.00 18.00	.....	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
Zirconium—Ferro Silicon, No. 2		8.00 12.00	Under 0.10	.....	.....	.....	40.00 45.00	12.00 18.00	.....	.....	.....	.....	.....	Electro Metallurgical Sales Corp., New York	1922
		Cerium Ce	Lanthanum La												
Cerium Alloy		60.00	25.00	Remainder almost entirely other metals of the						Cerium group.	.....	.....	.....	Fansteel Products Co. Product (Spring, The Foundry, July 1)	1922

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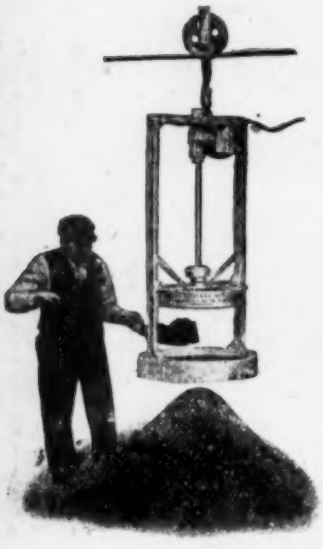
Note—This sheet may be cut along this line and one half folded over on the other to bind in a 5 x 7 inch note book

THE FOUNDRY DATA SHEET, AUG. 1, 1924

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

THE COST REDUCING GYRATORY RIDDLE

TYPE CS



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TYPE V

MADE AND SOLD BY

GREAT WESTERN MANUFACTURING COMPANY

LEAVENWORTH, KANSAS

July 19, 1923.

The Foundry,
Penton Building,
East 12th & Chestnut,
Cleveland, Ohio.

Gentlemen:

We think that you are entitled to know that through our advertisement in your publication we have received inquiries for our Combs Gyratory Foundry Sand Riddles from the most remote parts of the world, including India, Africa, Australia, Japan, New Zealand, and all parts of Europe.

Incidentally, we desire to emphasize the fact that we consider "The Foundry" by far the best means of reaching the foundry trade in this country as well as abroad.

We have sold over eight thousand of our Combs Gyratory Foundry Riddles in the last few years and a good portion of our sales can be traced to our advertisement in your publication.

The Englishman claims with pride that the sun never sets out of sight of British land, and our advertisement in The Foundry has finally placed us in position to state that the sun never sets out of sight of users of our Combs Gyratory Foundry Riddles.

We are firmly convinced that yours is the most widely read publication in the foundry world, and that is one of the reasons you find us a consistent advertiser both in times of depression and inflation.

Please accept our thanks for your high grade efficient service and your constant courtesy.

With best wishes, we are

Yours truly,
GREAT WESTERN MFG. COMPANY

P. L. Wilson
Treas.

PLW/RE

comes all over the coke the remainder of the bed of coke should be added. Again you should wait until a blue flame comes above the coke. The bed of coke now should be 28 inches above the tuyeres. This distance can be determined by a pole stuck down from the charging door, on which the correct height has been previously marked. An oil burner introduced through one of the tuyeres will serve to heat the coke bed in place of the wood.

After the bed has become heated as indicated by the blue flame, the pig iron of the first charge should be added, taking care to spread it well over the entire section of the cupola, and the scrap iron should be next charged. The amount of metal on the charge will depend upon the diameter of the cupola. A good rule is to use 1½ pounds of metal in the charge per square inch of cross section in the melting zone of the cupola. Thus if the cupola is lined to 40 inches in diameter the area will be approximately 1200 square inches and the metal on each charge should weigh about 1800 pounds. It would be well to start by using an amount of coke between the charges equal to ⅛ the weight of the metal is a charge. If this gives you hot enough metal the amount can be reduced slightly each day until the metal gives signs of coming too cold from the cupola. In this way you could determine the least amount of coke necessary. The blast should not be turned on until at least 2 hours after the fire has been lighted. This precaution is taken to insure a hot lining at the start.

The cupola should melt 10 pounds of metal an hour for every square inch of cross section in the melting zone, and enough air should be supplied so that there will be 30,000 cubic feet of air delivered for every ton of iron melted. This can be determined by securing a volume gage. A blast pressure gage also should be installed, and the blast should not be run higher than necessary for good working conditions. If more than 3 or 4 charges are melted in a heat it would be well to add 50 pounds of walnut size limestone on each charge for fluxing purposes and to give cleaner iron.

Making Large Strainer Cover Molds

BY JAMES J. ZIMMERMAN

THE manufacture of strainers or any of their various parts usually is associated with plants turning out a standardized class of work in large quantities according to a predetermined performance and with specially designed rigging and carefully laid plans. While all of these factors insure a high standard of quality and tend to place costs at a minimum, occasionally it is found that the manufacturers of these products are called upon to modify their designs to produce a piece or casting. Work of this nature requires complete changes in patterns and equipment and taxes the resources of the entire production department, especially the foundry.

Some time ago the Elliott Co., Jeanette, Pa., secured a contract to build several large twin strainers for an electric company in the southwestern part of the United States. These strainers were so constructed as to strain free from debris all water at a medium pressure or head passing through a pipe having a 42-inch diameter. The strainers were made up of a number of parts, and with the exception of the covers, required nothing out of the ordinary in the foundry. Making these covers, or inlets and outlets, which were only ⅞-inch in sectional thickness and weighed 7500 pounds, presented several interesting features.

In general, the cover castings were pit jobs and were made in dry sand with two drawbacks. The main core was suspended from the cope and two secondary cores were used making the covers required 35 hours of core making and 82 hours of molding time. Special coreboxes were used for ramming all of

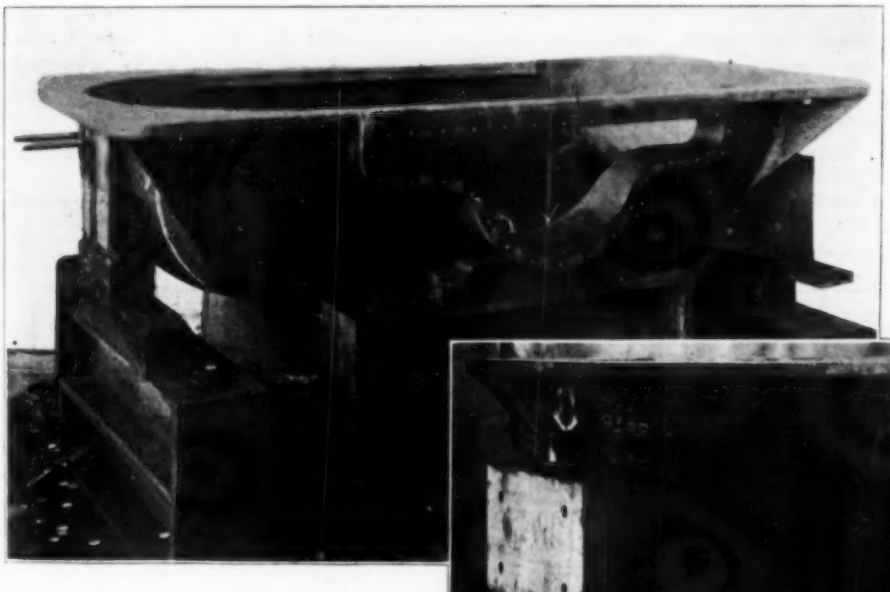


Fig. 1—Above—Large Cover Castings for Twin Strainers Which Required a Special Method for Molding—Fig. 2—Below—Opposite View of Casting

the cores. The cores were well rodded and filled in the centers with coke for venting purposes. Three component parts of the core may be seen in Fig. 3, the parts being marked *A*, *B*, and *C*. In addition to the main core, shown at *A*, being well rodded and coked for venting, it was fitted with a cast-iron lifting plate by which it was suspended from the flask, shown at *F*, which was used as the cope. Standards were placed between the lifting plate and the lateral bars of the flask to prevent crushing the core when it was being bolted to the flask.

Drawbacks Necessary

First the pattern was placed in the pit and sand rammed around it with the exception of the two drawbacks shown in *C* and *D*, Figs. 2 and 3, respectively. The two drawbacks afterward were built around or on cast-iron lifting plates and were made of loam and brick. The main drawback, shown at *C* in Fig. 3, which was tied securely from the bottom to the top by several through bolts and a binding plate, was constructed in a rectangular shape on three sides while the side adjacent to the pattern followed the contour of the cover for a portion of the way to the top and then followed the center line of the nozzle to the bottom. Nothing especially interesting was encountered in making the small drawback shown at *C*, Fig. 4, except that it was made in loam and was constructed with a lifting plate to facilitate lifting it away from the pattern.

After the molds and the drawbacks were rammed, the latter were pulled away and the pattern drawn straight from the mold. The mold then was dressed and coke fires placed on the inside for drying. From the transverse section drawing, Fig. 5, the general dimensions and the interior construction of the cover may be seen. The lugs, which may be seen in Fig. 2, offered little or no difficulty to the core makers, for they were formed and the patterns later were picked or drawn from the core in the customary manner. After the cores were completely formed, they were dressed and dried in core ovens.

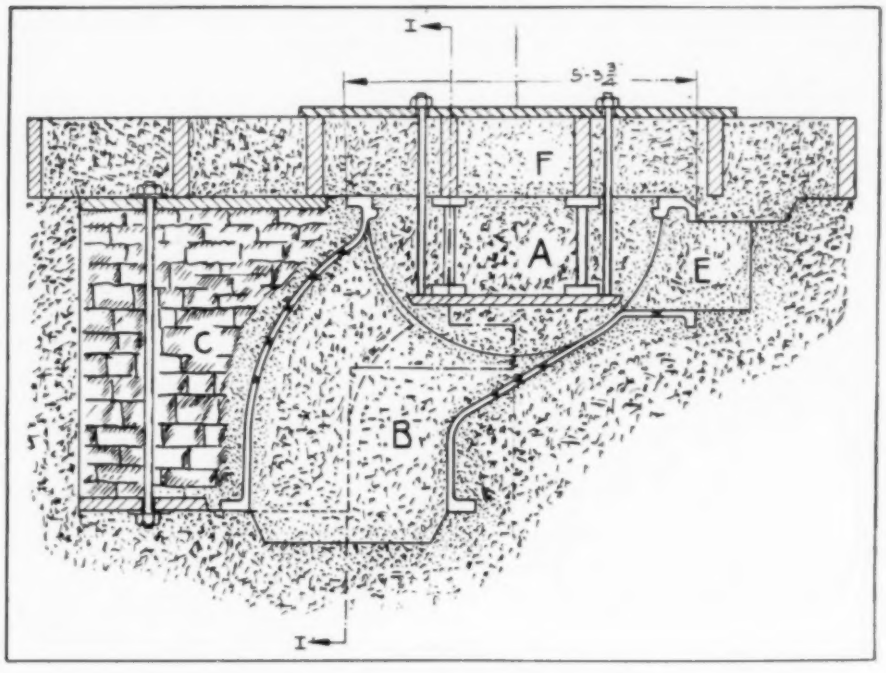


FIG. 3—THE MAIN DRAWBACK WAS SUPPORTED BY SPECIAL RODS AND PLATES SUSPENDED FROM THE FLASK

After the cores and the molds and the cope were dried completely, the core *B* was put in the mold, as well as the core *E*, both of which were held in position by chaplets. The drawbacks then were pushed into position. Chaplets were placed to prevent the drawbacks being pushed far enough to reduce the metal section, and to hold the cores down and prevent their lifting during pouring. After the drawbacks were in place, they were rammed so as to be held immovable, and the cope with the main core *A* was lowered into position.

The covers were poured simultane-

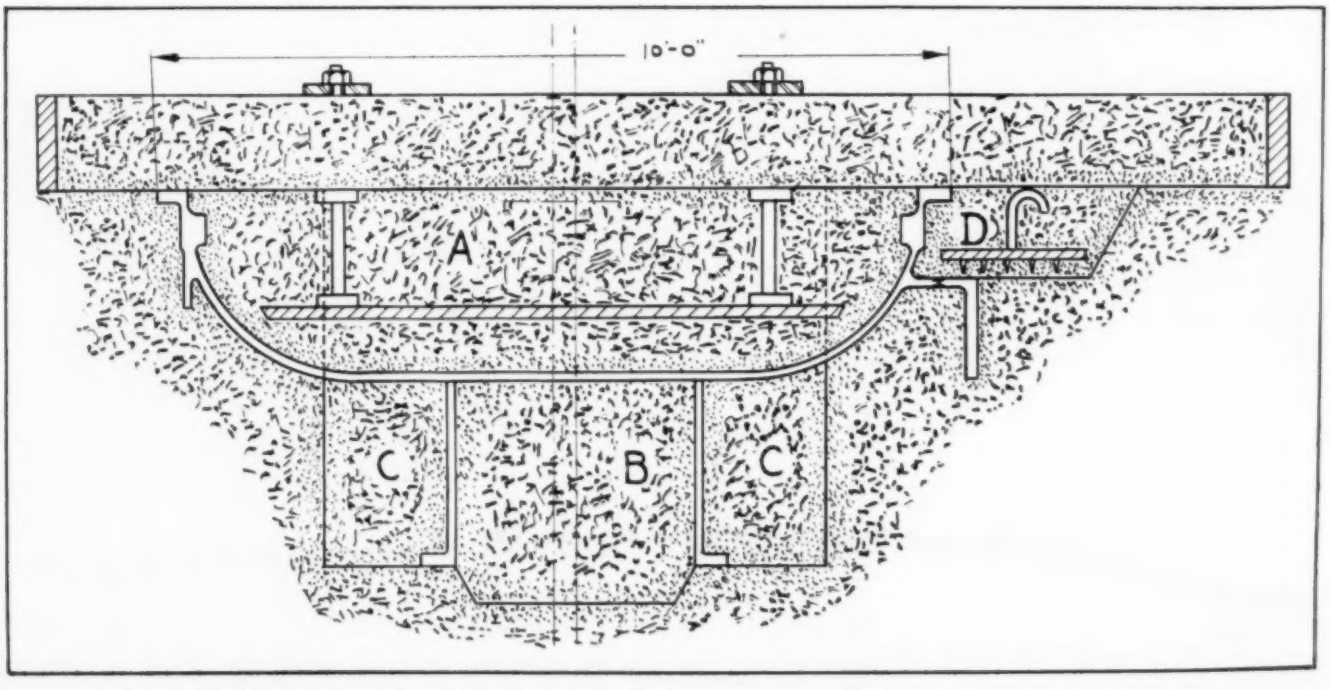


FIG. 4—DRAWBACKS WERE NECESSARY IN ADDITION TO THE CORES IN PREPARING THE MOLD

ously from both ends with gates and runners supplying metal to the ends of the top flanges and both sides of the flange of the nozzle at the bottom of the mold. Due to proper care and workmanship no difficulties were encountered during any part of this work.

Foundry Students Win British Prizes

At the International Foundry Trades Exhibition held at Bingley hall, Birmingham, Eng., June 19 to 28, a series of competitions took place, open to foundry employes, ex-service trainees and technical school students, male or female, of Great Britain. The competitions were taken up with considerable interest and the following is the list of prizewinners:

Class A.—For making the best core in one of the following sections:

Section 1.—For light castings

Type (a) A cylinder head core in oil sand. For candidates under 21 years of age.

1.—S. Mason, Midland Motor Cylinder Co., Ltd., Smethwick.

2.—P. C. Lindon, Humber, Ltd., Coventry.

Extra prize, B. C. Cumming, Belliss & Morcom, Birmingham

Type (b) A water cooled jacket cylinder core in green sand. For candidates over 21 years of age.

1.—J. Hulston, Humber, Ltd., Coventry.

2.—H. Brooks, Wolseley Motors, Birmingham.

Consolation prize, C. H. Clarke, Williams Mills, Birmingham.

Section 2.—For medium castings. (Open)

A valve core.

A motor or dynamo center core with poles or other suitable core.

1.—T. Perry, Kynoch Ltd., Witton.

2.—Miss G. Smallwood, Ham, Baker & Co., Langley Green.

Consolation prize, J. Wild, Rudge Littley, Ltd., West Bromwich.

Section 3.—For heavy castings. (Open)

A strickled core.

A turbine pump rotor core.

1.—J. A. Spare, Harper, Sons & Bean, Tipton.

2.—G. H. Price, Tangyes, Birmingham.

Consolation prize, W. Stevens, Rudge Littley, Ltd., West Bromwich.

Class B.—For making the best mold in each of the following sections:

Section 1.—Floor molding.

1.—E. L. Porter, General Electric Co., Witton.

2.—C. Goodman, General Electric Co., Witton.

3.—F. T. Ferriday, Harper, Sons & Bean, Tipton.

Extra prize, T. Hopcroft, General Electric Co., Witton.

Consolation prize, G. W. Mitchell, E. Green & Sons, Ltd., Wakefield.

Section 2.—Two part work molding.

1.—L. Walters, Harper, Sons & Bean, Tipton.

2.—C. Meredith, Tangyes, Birmingham.

Extra prizes, E. A. Rollason, Humber, Ltd., Coventry.

R. S. Turner, Wolseley Motors, Birmingham.

H. W. Hall, Midland Motor Cylinder Co., Birmingham.

W. C. Rabin, John Wright & Co., Birmingham.

Consolation prize, R. H. Mitchell, London & North Eastern Railway, London.

Section 3.—Three-part molding.

1.—W. Lloyd, Humber Ltd., Coventry.

2.—W. Brant, Ham Baker & Co., Langley Green.

3.—L. Ramsbottom, John Harper & Co., Darlaston.

Consolation prize, H. J. Morgan, Oak Foundry, Ltd., Birmingham.

Section 4.—False core work—ornamental molding.

F. Beckingham, Humber Ltd., Coventry.

Class C.—For making the best pattern to a blue print design to be supplied to each competitor:

Section 1.—Open to all over 21 years of age.

1.—W. L. Leek, William King, Ltd., Birmingham.

2. J. B. Jones, Archdale Co., Birmingham.

Consolation prize, A. Moore, General Electric Co., Witton.

Section 2.—Open to all under 21 years of age.

1.—G. W. Sims, William King, Ltd., Birmingham.

2.—T. V. Upton, Fellows & Darby, Birmingham.

3.—S. J. Essex, Wolseley Motors, Birmingham.

4.—W. W. Grew, W. J. Flavell & Co., Wednesbury.

5.—A. Henderson, Wolseley Motors, Birmingham.

Consolation prize, J. Turner, Wolseley Motors, Birmingham.

Section 3.—Open to students at any technical school in Staffordshire, Warwickshire and Worcestershire, under 21 years of age.

1.—F. W. Evans, Vulcan Pattern Making Co., Coventry.

2.—W. J. Sandland, C. A. Daniel, Birmingham.

Consolation prize, H. Kendrick, Rudge Littley, Ltd., West Bromwich.

The special prize given by the Worshipful Company of Ironmongers of London for the best pattern in the entire class C was awarded to F. Atkins, Brooks, Oldbury, Ltd., Oldbury.

Value Castings Made in Steel

(*Concluded from page* 583)

pattern is removed and returned to the molding machine and the drag is picked up by the crane and placed either on the oven car or temporarily on the floor until the car is ready. The drag contains the lower flange and the body of sand forming the interior opening through the casting. The cheek may or may not be rolled over after it is rammed. This feature depends on the construction of the pattern. The same applies to the cope. The gating arrangement is as shown in Figs. 6 and 7. The round block shown in the center of the drag pattern *A* Fig. 6 forms an opening in the center of the core and serves as a vent while the core is drying and also while the mold is filling with metal later. The opening also is an important factor in facilitating the crushing of the core under the contraction strain of the casting while going through the process of cooling. It also saves a certain amount of sand in each mold and in addition forms a convenient starting point for the removal of the sand after the casting has been shaken out.

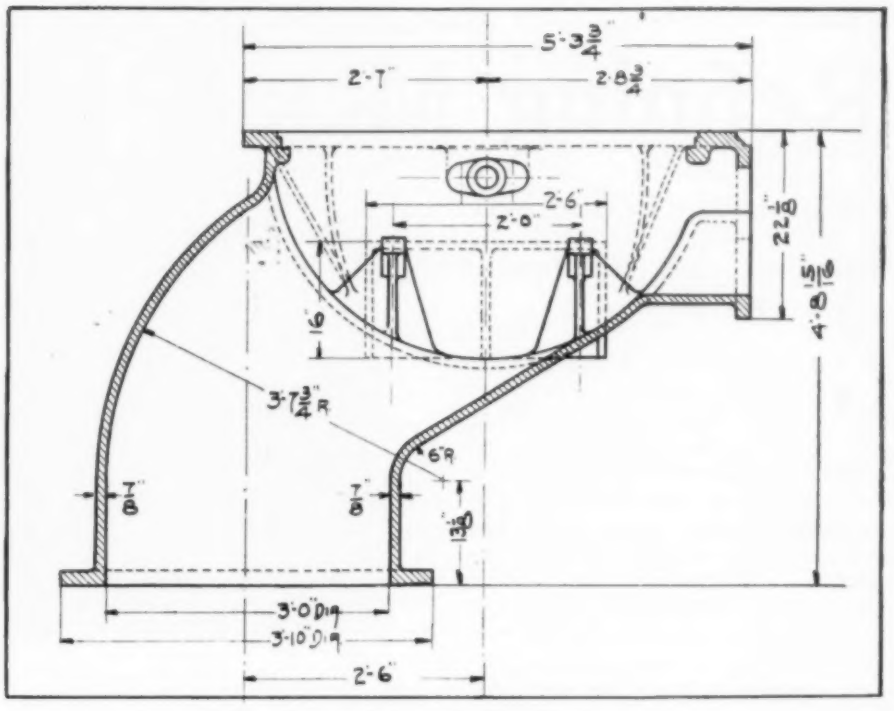
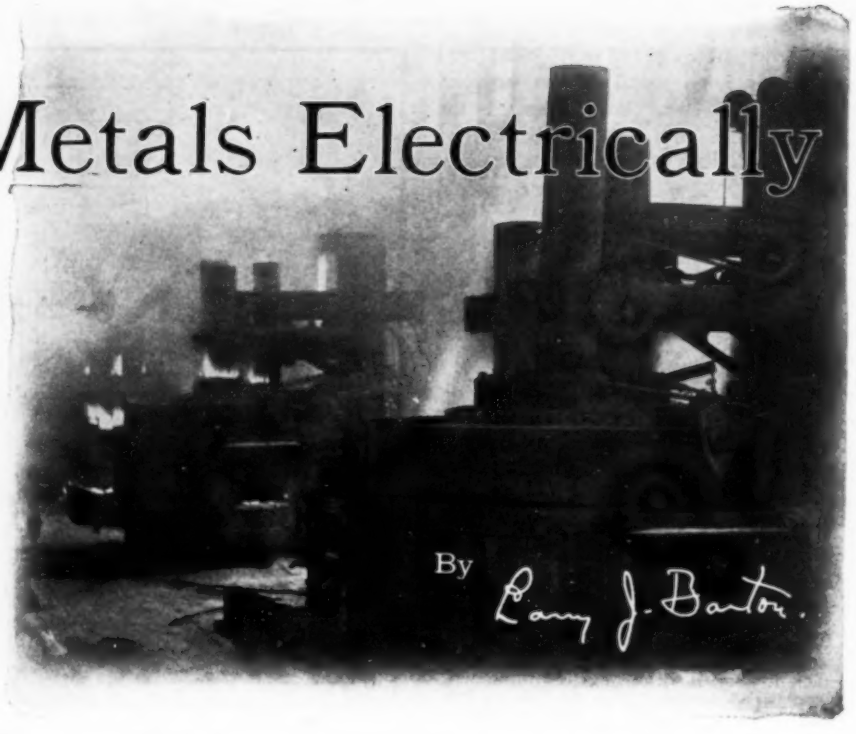


FIG. 6—TRANSVERSE SECTION OF THE COVER SHOWING THE INTERIOR CONSTRUCTION

Steel for the castings is melted in an acid lined electric furnace made by the Pittsburgh Electric Furnace Corp., Pittsburgh. It has a rated capacity of 4000 pounds, but excess charges up to 8500 pounds have been melted to meet emergency conditions. Usually five ordinary charges are melted during the period of an 8-hour working day. The metal is tapped into a bottom pour ladle and transported to the pouring floor by one of the two 5-ton electric traveling cranes supplied by the Chesapeake Iron Works, Baltimore. These cranes span the building from side to side and operate on tracks that extend from one end of the building to the other and are employed for a great variety of purposes in addition to being used for handling the molten metal.

One end of the building is maintained as a cleaning room and is equipped with all the necessary and usual mechanical cleaning devices including cutting torches, grinding wheels, pneumatic chisels and three jib cranes for handling the more bulky castings.

Refining Metals Electrically



Chapter II (Continued)

How Basic and Acid Linings Are Applied

GREAT diversity of opinion exists regarding the time necessary to set a hearth, and whether it is preferable to finish the job in one operation. The writer has used over 25 hours on a 6-ton furnace, and later on the same equipment placed a hearth in 11 hours. Both hearths ran indefinitely, the first being removed to try acid operation after running over 2000 heats. The second was placed in operation in 1921 and is still in good condition, in a shop operating 6 heats per day. The variation in time was due to difference in experience of helpers, slightly changed power conditions, different magnesite, and such causes. Making a hearth is similar to making a heat steel, in that the greater the care the better the product.

The practice of finishing the hearth in one operation, is preferred and a great saving in time and power is affected by such practice, due to the fact that there is no cooling down of the furnace over night. Further a hearth made in one operation is better than one allowed to cool over night for the reason that there is no possibility of a seam occurring between layers. Many successful operators allow their furnace to remain shut down over night, and they have had good success in hearth building.

Fig. 11 shows the appearance of the finished hearth made by burning on a stepped brick bottom.

Often after burning in a bottom it is customary to make the first melt a *wash heat,* little care being used to make any particular quality of metal, the main idea being to assist in setting the bottom, and to remove any loose material. Often, the bottom electrode setup becomes frozen in and it is impossible to remove it without this wash heat.

Under ordinary circumstances it is not necessary to make such a heat, but the furnace may be operated directly on steel for whatever purpose desired. If there is no particular hurry to make finished material, it is excellent practice to set the bottom by such a heat as is mentioned. The best possible type of a melt for such purpose is one of *synthetic* iron. Any grade of steel scrap is thrown in the furnace with sufficient carbon to raise this element up to about three per cent. After melting, a heavy lime slag is made up, which is splashed as high up on the walls as is possible. Such a heat closes any small cavities in the hearth, aids in bringing up the side walls, and thoroughly removes any foreign matter from the furnace. The iron produced if poured into small size pigs is later used for recarbonizing.

While on the subject of basic bottom making, it might be well to mention certain machines built to throw patching material automatically into the furnace. Such equipment does not find wide use in small installations such as are found in casting shops, but is important in the larger installations. A smaller counterpart of the standard machine may be made and gives excellent service in patching the side walls, especially around the roof ring.

One type of machine is the standard cement gun which has found wide use for placing cement into position. This comes in different sizes, the smallest being handy for electric furnace use. Another type of machine is intended for open hearth use where large quantities of patching material are used at one time. The principle of these machines is a stream of air being forced through a hose, the suction produced carrying the patching material with it. Naturally all that is needed is to point the nozzle at the desired point, turn on the motor, and as long as the tank remains full of refractory the machine will place it.

Spouts and Door Linings

Due to charging and pouring operations, the wear around the doors is severe and some method must be devised to keep these important points in condition. The pouring spout, and around the jambs is made of magnesite, but unlike the hearth proper, is never under sufficient heat properly to sinter this refractory in place. These places must be kept up by ramming refractory mixtures into place, and due to the lack of cohesiveness of magnesite a natural binder must be used. The best the writer knows for such a purpose is sodium silicate.

After pouring, any slag or small metal sculls are removed from the spout with a sharp pointed bar, and a mixture of magnesite and sodium silicate rammed into place. This mixture is made of such a consistency as to be just moist to the feel, and after air setting for about an hour, makes a hard and durable re-

Burning Linings

VARIOUS practices are followed for burning in linings of electric furnaces. In this article, the author outlines the detailed operations followed in setting basic and acid hearths, giving logs which are in effect hourly records of the steps taken, indicating the current applied, when the different materials are added and pointing some of the obstacles encountered. Finishing the hearth in one operation is preferred. In the next installment which will appear Aug. 15, the shape of the hearth in relation to operating results, making the spouts and door openings, care of electrodes and some suggestions on primary charges will be offered.

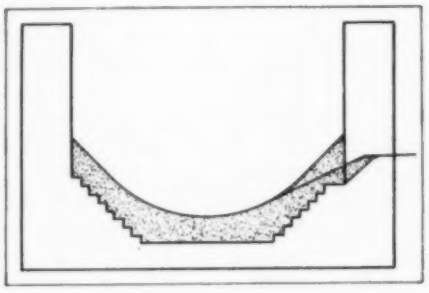


FIG. 11—FINISHED SHAPE OF HEARTH MADE BY BURNING IN A STEPPED BRICK BOTTOM

fractory. The same mixture may be used around the door jambs with excellent success.

Of late years extensive experimentation has been conducted with refractories which will better stand the rough usage of the basic furnace than the ordinary magnesite and silica brick. The main objection to silica brick above the slag line is its short life. With the basic slags used, a heavy lime vapor always is present in the furnace which at the high temperatures attained rapidly attacks the acid silica brick, especially at the points opposite each arc. Here the arc often is deflected against the wall causing the brick to assume a pasty condition. Now when the heavy lime slag is splashed upon this acid mass, rapid disintegration follows, the result being a wall so cut in at these points that a relining, with its loss of time and tonnage, is mandatory. Such a condition is shown in Fig. 12.

This fault being common to all silica brick used in lining basic furnaces, many methods have been advocated to eliminate this objectionable feature. One of these is to use magnesite brick for the entire wall. Naturally this overcomes any slagging tendency, but again brings another objectionable feature, that of spalling. Magnesite brick lacks strength under changing temperature and this is evidenced by heavy spalling and flaking of the brick surface. Under standard conditions of operation this is so severe

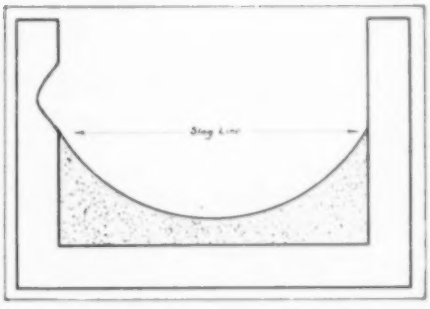


FIG. 12—SILICA BRICK USED IN BASIC OPERATION IS ATTACKED BY LIME VAPORS AT THE SLAG LINE

Table X

Log of Bottom Burning Basic Lining

SIX-TON HEROULT FURNACE

FURNACE bricked up with flat bottom, two courses of clay and two courses of magnesite brick. Dead corners rammed in with a mixture of four parts of magnesite to one of basic open-hearth slag, using tar as a binder. This mixture rammed up along walls as high as possible to tend to prevent spalling of the magnesite brick during heating up. Electrodes set "star" with joint heavily sealed with electrode chips and compound. Set up placed on seven and a half inches of magnesite brick, well cemented into place.

Furnace heated up to a good hot temperature by means of two oil torches inserted through the charging doors.

The electrodes were removed from furnace and complete hearth examined. A bar run against hearth showed it to be hard. The bottom was 12 inches deep in the center. The total elapsed time the current was on was 19 hours. Delays outside of shut down consumed 1 hour. The power consumption was 10,800 killowatt hours.

This hearth went over 2000 heats before being removed to change furnace over to acid operation. On removal perfect burning was shown to have been accomplished clear through to the brick.

FIRST DAY

4:30 p. m.
Current on at 2000 amperes, drawing a load of approximately 500 kilowatts. Arc irregular but holding well.

5:30
Current raised to 3000 amperes drawing a load of 700 kilowatts. Slight amount of spalling especially in front of door openings. Raked these pieces of brick out with fettling spoon.

6:30
Current raised to 4000 amperes, 900 kilowatts. Furnace slowly heating up. Spalling ceased.

7:30
Center plug slipped breaking contact. Set two loose electrode screws along side joint giving new connection. Furnace at a fair red heat. Tar burning out of rammed corners. Steam still coming from bottom vent holes.

8:05
Current on at 900 kilowatts. When electrodes were lowered one was allowed to strike setup breaking electrodes apart, but due to good luck it slipped back into place when pressure was removed.

9:45
First addition of refractory material, made consisting of a mixture of magnesite four and ground slag one part. Four shovelfuls carefully scattered over entire hearth. Current raised to 1200 kilowatts to overcome cooling caused by this addition.

10:10
Silica brick running slightly, but not enough to cause any danger. Tests taken from four quarters of hearth all show good sintering. Another quantity of the same four to one mixture added, about 100 pounds, thrown around the hearth edge.

From this time up to 1:00 a.m. additions were made at intervals of approximately 30 minutes. Tests were taken before each addition from in front of each of the three doors, between each door, and from behind the center electrode, making six tests on each trial. Constant adjustment of the mixture was required to give proper sintering conditions, using either more slag or magnesite to balance. The setup by this time had become badly burned at the joint and was arcing with sufficient strength to form a molten area about a foot in diameter in the center of the hearth, and about 2 inches in depth. The arc was of such violence that the carbon was rapidly reducing the magnesite with which it was in contact, and the gas was so strong that nothing could be seen when the doors were opened.

SECOND DAY

1:00 a. m.
Shut off current, and removed electrode stubs from the furnace. As soon as furnace had cooled sufficiently for a man to enter it was carefully examined. In the center where the carbon had fallen into the magnesite there was a bad patch where the magnesite had been reduced. This was dug out for a depth of about 1 inch. Along the walls the silica brick had run slightly requiring a small amount of chipping to clear this accretion. Remainder of hearth was in excellent condition being extremely well burned and hard.

Another similar setup made, placed on five and one-half inches of magnesite brick.

5:10 p. m.
Current again on at 500 kilowatts.

6:10
Current increased to 600 kilowatts. Furnace warming slightly with no evidence of spalling.

7:10
Raised to 750 kilowatts.

8:10
Increased to 900 kilowatts. Furnace becoming hot, but a test did not show any evidence of sintering.

8:30
Test shows evidence of pastiness from the six test positions. Three scopps of a mixture of magnesite six and slag one thrown in directly behind the center electrode where a hot spot was developing, due to arc flaring against wall. Walls glistening slightly, but no signs of running.

8:35
Due to carelessness of helper electrode was allowed to strike setup while lowering, causing setup to break apart. Bars were put into furnace and the setup was pried back into its regular position. A magnesite brick was placed alongside of each electrode to hold it in position and prevent any further tendency to roll out of place.

9:00
Current on again, new setup working fine and holding current with no signs of arc at joint. Current running at 900 kilowatts.

9:40
Current cut to 700 kilowatts. Additions of the six to one mixture again started, being made approximately every 30 minutes. Test showing perfect sintering, although constant adjustment is required.

10:30
Current cut to 600 kilowatts. Walls beginning to assume bowl shape. Spout beginning to form nicely.

11:40
Current again cut to 500 kilowatts to prevent walls running. From this point on the mixture was cut down to about 10 of magnesite to one of slag and moistened. Spoon used on all additions and mixture placed up along walls to form bowl. Center of hearth is now of sufficient depth. Spout shaping out as far as tapping door. All additions now being made without shutting off the current.

THIRD DAY

3:00 a. m.
Final addition made along walls, complete hearth being given a light dusting of slag.

3:40
Complete hearth appears molten due to the slag running. Shape perfect. Spout finished. Current shut off and furnace allowed to free itself of gaseous vapor. Electrodes pulled up on walls and slight depressions under each filled with a six to one mixture well rabbled in, to give hearth final rounded shape.

Table XI

Log of Bottom Burning Basic Lining

THREE-TON HEROULT FURNACE

ELECTRODES were arranged on bottom brick in the form of a star, elevated on 5 inches of magnesite brick. A plug was set on top of three stubs and carefully cemented in place with electrode compound.

FIRST DAY

8:00 a. m.
Current on low voltage side of transformer drawing approximately 1000 amperes at 90 volts. Bottom of furnace dusted slightly with powdered open hearth slag. Current gradually raised at intervals until a load of 3000 amperes was being taken. Heating continued until 2:00 p. m. when furnace was hot and slag had been running freely for about 15 minutes.
2:00
Doors opened and electrodes raised and about 5 shovels of straight magnesite thrown in center of furnace around electrodes, mainly to cool them a little.
2:30
After this first addition had sintered into place another light touch was given around the rim of bottom especially where the arc was striking freely.
3:15
About 200 pounds of magnesite again added being distributed in a uniform manner over the hearth.
4:00
Perfect sintering being obtained up to this point. Furnace shut down until next morning. About 3200 kilowatt hours had been consumed up to this time. All door and electrode openings carefully luted with clay to retain as much heat as possible.

SECOND DAY

8:00 a. m.
Temperature of furnace still a fair red, probably about 1400 degrees. Current on low voltage at 3000 amperes. Furnace rapidly heating under arc.
9:00
Center of furnace under setup getting rather hot. Two shovels of magnesite thrown in around stub to cool off hot spots.
9:15
Four full scoops of magnesite spread over entire hearth. Furnace extremely hot, and sintering proceeding nicely.
10:00
Voltage changed over to high side—120 to 130 volts, amperes cut to 2000.
11:00
Charged four full scoops of a mixture of magnesite two and slag one around banks of furnace. Sintering proceeding well.

that the extra life obtained over silica brick is not sufficient to make up for the increased cost.

Such materials as mica schist, special alumina bricks, and refractories containing zirconium have been advocated as a cure for these troubles, but none have been thoroughly satisfactory. Carborundum brick have proved satisfactory, as have brick made of the same quality of magnesite as goes into the standard product, but surrounded by a thin sheet metal case. When placed in the furnace this metal melts on the outer few inches and binds the wall together in one compact mass. The steel shell further prevents spalling or flaking by acting as a support to the magnesite itself. The added cost of these brick will be more than made up by increased life of walls and avoidance shutdowns. When a wall laid with these brick does fail it has the appearance of that shown in Fig. 13. When the furnace is relined these short pieces of brick from the top of the wall may be used to patch lower down with the elimination of any waste.

Carborundum made into brick form lately has found wide use for certain purposes, but due to its high cost generally is not used for entire walls. This compound is negative to a basic slag, but is corroded and dissolved by hot metal. Therefore, it must be used in the furnace where it is removed from any splashes of metal, and for such uses where its cost may be reconciled. It has found a steady increase for such purposes is a small patch directly behind each electrode where the arc strikes, being placed just high enough to be out of the reach of any metallic splashes, for arches, and for the skew back ring of the roof.

Carborundum brick have been used in many instances for entire roofs, but due to their ability to conduct current it has been necessary also to use some non-conduction brick which give way first and destroy part of the efficiency of the carborundum.

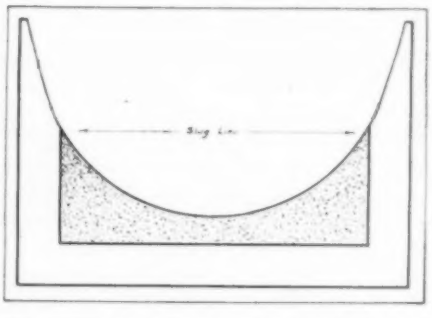


FIG. 13—BRICK FOR BASIC LININGS OCCASIONALLY FAIL IN THIS FORM LEAVING SHORT LENGTH NEAR THE SLAG LINE

Table XII

Log of Bottom Burning Basic Lining

THREE-TON PITTSBURGH FURNACE

DUE to the rounded shape of the hearth of this furnace, the bricking up of the hearth was simple. Two courses of fire brick were laid next to the shell, followed by magnesite brick two high. The side walls in this furnace were laid completely to the roof with a metal encased magnesite brick. The hearth was stepped up so that all that was required was to burn in a layer of hearth approximately seven inches thick in the center and tapering off to about three inches up along the banks.

The setup was laid in the form of a T so arranged that the bottom of the T was parallel with the door openings. Electrodes were set on 7½ inches of magnesite brick.

FIRST DAY

7:00 p. m.
Current on low voltage side of transformer drawing about 140 volts, with amperes cut down as low as possible. Preliminary to turning on power, furnace had been thoroughly dried and heated with two oil torches. Due to high voltage, arc was irregular for the first 15 or 20 minutes until a red spot had been heated on the setup under each electrode. This heating continued with a gradual increase of the amperes up to 4000.
11:00
Furnace smoking hot, walls beginning to drip slightly. Light touch of magnesite around banks with a small amount of acid open hearth slag in the center of the furnace.
12:00
First large addition of magnesite mixed with acid slag in the proportion of approximately 20 to one, the slag being powdered and the magnesite wheat size.

SECOND DAY

From this point on additions were made about every half hour, depending on the character of the tests as taken by a small chisel spoon. Great care had to be exercised regarding the acid slag, only enough slag being used to aid in holding the magnesite. This required constant adjustment.
4:00 a. m.
From this time on all material moistened and placed in position with a spoon. Some trouble was experienced in obtaining a good shape behind the head of the T, but this was accomplished by taking plenty of time and dropping the mixture high up on the wall from which position it naturally dropped into its proper position.
8:30
Hearth finished and furnace ready for steel.

Lining An Acid Furnace

BUILDING an acid-lined furnace involves procedure similar followed for basic units. The lower courses will be of fire brick, set in exactly the same manner, and the side walls consist of silica brick alone. The same features of allowing for expansion, etc., are followed, and the two methods of either stepping up the hearth brick, or laying flat will be optional. This point is not of such great importance as in basic operation, but depends entirely upon what method will be pursued in setting the hearth. If the hearth is to be rammed and baked, there is no necessity of stepping off the brick; if the hearth is to be burned, stepping the brick will give similar economies to those encountered on the basic hearth.

The deciding point in brick laying therefore, will follow the choice of bottom making. Acid refractories have a

Table XIII

Log of Bottom Burning Acid Lining

SIX-TON HEROULT FURNACE

HEARTH was stepped up using the best grade of silica brick obtainable. The electrodes were set in a V with apex under the center electrode of furnace, raised up 5 inches above bottom by placing on silica brick two high. Brick cemented into place with a mixture of sand and sodium silicate, some sodium silicate being also used to cement the electrodes to the brick. Furnace thoroughly dried out with oil torches and heated up to a low red.

2:00 p. m.
Current on low voltage side of transformer drawing 2000 amperes at 100 volts.
3:00
Current raised to 4000 amperes. As a slight running of the walls or roof is immaterial in an acid furnace it is allowable to heat up much faster than on basic practice. With no magnesite brick in the furnace there is small likelihood of spalling occurring in any great amount.
4:00
Furnace up to a good red heat. Current off for about 5 minutes while a few brick stubs from roof were raked out of furnace with a spoon.
5:00
Furnace smoking and roof beginning to drip. Current cut to 3000 amperes and first addition of patching made. This consisted of two parts —one of about 200 pounds of clear sand thrown high on the banks to neutralize any drippings from the side walls. The second consisted of 10 of sand to 1 of fire clay spread over the entire hearth.
6:00
About 1 inch of 10 to 1 mixture spread over entire hearth, and placed as high on the banks as was possible.
Examination of furnace while current was off showed slight running of the roof, and rather heavy running of walls opposite the arcs. Several shovels of straight sand thrown over each of these spots.
7:00
Current being held from 2000 to 3000 amperes. Tests taken show fair sintering in spots, unburned areas in others. Where sand had not sintered added a richer mixture consisting of 8 sand to 1 of clay, dusted on lightly. Burning excellent on hearth proper and on areas in vicinity of arcs. Worst unburned areas were in front of doors and in pouring spout.
7:30
Tests taken and more sand added where needed. Burning progressing nicely. Depth of burned sand in hearth about 2 inches as shown by test rod, and walls assuming rounded shape. Corners of bricks still showing slightly on stepped up banks.
7:45
Another heavy addition of 10 to 1 made all over hearth and walls; 8 to 1 being used in front of doors and to shape pouring spout. Bar shoved into hearth shows pasty for about ¾ inch with a hard under surface.
8:30
Further patching made, but mixture changed to 14 to 1 and current raised to 4000 amperes. Tapping spout built up from front of furnace using a long handled shovel, sand being moistened with a solution of sodium silicate in water, about half and half.
9:15
Final additions made with spoon, principally along the banks, sand being well soaked with water.
9:45
Final tests taken from all points of hearth show fine sintering. Light dusting of pure sand, probably ½ inch thick made with spoon. Current raised to 6000 amperes allowing furnace to drip.
10:30
Current off, electrodes knocked out of hearth and holes filled with 10 to 1 mixture well rabbled in. Electrodes lowered and doors closed and furnace allowed to soak.
12:00
Stubs removed from furnace and ready for steel. Hearth in center 5 inches deep, tapering to a 2-inch thickness near top of banks.

Due to a shortage of acid scrap occurring this hearth was taken out after several hundred heats. Upon examination a perfect burning in was shown, the burned in sand being in one hard, monolithic layer firmly welded into the bricks, and requiring sledge hammers to break it out.

much lower melting point than magnesite, and may be bonded with excellent acid cements. Consequently, the necessity of actually burning in bit by bit is not essential to a good hearth, although it is common practice among a large number of furnace men. The rammed hearth is just as good and is much more economical, besides being an easier job, and one in which a better shaped hearth may be attained.

Assuming that this method is to be followed, the brick are offset as described under basic practice. The furnace is dried out, and the electrodes set up on the bottom brick in any manner desired. The depth of hearth desired will determine to what height they are elevated by silica brick. The current is turned on until the furnace is sufficiently hot to sinter in the refractory, when building commences. Any good grade of silica sand is satisfactory, finely ground fire clay being used as a binder similarly to open hearth slag with magnesite. The general mixture used approximates 12 to 15 parts of sand to one of clay, but this requires constant adjustment for the proper degree of sintering.

Care must be exercised to prevent the furnace from becoming too hot or the furnace brick will run badly and contaminate the hearth with burned silicate which has poor refractory qualities.

Ramming an acid bottom is rapidly assuming favor over the old burning process. This, in all probability, has been due to the labor entailed being so much easier, the burning of a bottom being truly a heart breaking operation. Too, ramming is so much cheaper and quicker. The real point is of course the service obtainable under operation conditions, and it must be admitted that the rammed hearth for acid steel is giving just as good results as one burned in.

In the preparation of such a hearth, there is no necessity of stepping up the brick, and consequently the bottom brick are laid flat. The usual procedure of

Table XIV

Log of Bottom Burning Acid Lining

SIX-TON HEROULT

DUE to a mistake this hearth was built with straight sides instead of being stepped off, and serves as an excellent comparison with the preceding log. The bottom setup was raised 5 inches and cemented into place, but a star arrangement was used. Before burning was started the dead corners were rammed in with sand mixed with glutrin, so that the depth from the corner to the surface was probably 10 inches, this being as an aid in forming the curve.

Furnace brickwork was dried out with three gas flames inserted through each door for about 8 hours. Furnace was a fair red when current was first thrown on.

FIRST DAY

8:00 a. m.
Current on at 2000 amperes and 100 volts.
9:00
Raised to 3000 amperes, few pieces of brick being taken from furnace.
10:00
Furnace beginning to smoke.
11:00
First addition, straight sand being thrown around center setup, about 1 inch in depth.
12:00
Addition made of 12 of sand to 1 of clay over entire furnace. Additions made about every 45 minutes with constant tests. Progressing nicely until 6:00 p. m.
6:00 p. m.
Stub connecting three electrodes slipped breaking contactand causing arc to dig into hearth. Slid back into place, and two electrode nipples placed along each side of pile of sand. This helped to strengthen setup which held well when current was again turned on. Several shovels of sand thrown in where arc had struck.
7:00
Current again on. Furnace had cooled down considerably so amperes were raised to 5000.
8:00
Current cut back to 3000 and another addition made.

SECOND DAY

Additions made at intervals until 2:00 a. m.
2:00 a. m.
Current off, electrodes raked out, and furnace ready for steel.

This hearth was placed in operation in 1920, and is still in use over 12,000 tons of casting steel having been made with no trouble whatsoever.

laying two courses of clay brick against the shell, followed by two of silica is customary. In laying these silica brick, allowance must be made for expansion or future heating will bulge the hearth. As soon as the furnace has been completely bricked, the hearth is given a coating of some binder to cement the bottom of the hearth to the bottom brick.

There are many satisfactory cements or mixtures for this purpose. Glutrin, sodium silicate, and a number of specially prepared high temperature resisting cements all have acceptable properties, that of air hardening and setting with a perfect bond. All have good refractory characteristics, and may be used with success. About three or four hundred pounds of sand is mixed to a moist consistency with one of these binders. A patch along one side of the hearth then is smeared with the cement and while still moist, the sand is shoveled in and rammed well. This is continued until the entire hearth is so covered. As the hearth rises up on the walls they also are painted to insure the sand holding firmly to the brick.

The sand mixture thus is raised gradually until a hearth of the desired depth and shape is formed. Air rammers are used and it must be remembered that the hearth cannot be rammed too hard. The entire hearth should be as hard as a brick before the next layer is added, and it certainly pays to devote plenty of time to this important operation. Should it be necessary for any reason to stop, allowing a layer to air set, the entire surface must be painted with cement before another layer is put in.

While the sand may be mixed by hand using shovels, it is much preferable to use a sand mixer or muller if this is available. This not only is quicker and easier, but gives a better mix to the material. After the hearth is rammed, the furnace should be tilted in each direction, and the mixture rammed up as high along the back and front wall as possible. When burned into place this furnishes a wonderful aid not only in keeping the furnace free of hanging scrap, but gives a much prolonged life to the side wall refractories.

Contraction of Cast Iron

By George A. Drysdale

Question: Does cast iron shrink uniformly from pouring heat until it is cold?

Answer: To answer this question in a satisfactory manner we must define the difference between shrinkage and contraction. *Shrinkage* is a term used to cover a volume reduction in the fluid mass of iron as it sets which gives rise to empty spaces within its structure, and may result in only a slight porosity in thin sections, but in thick sections may exhibit itself in large voids.

Contraction may be referred to as the difference between the size of the casting and pattern and is given in fractions of an inch per foot although it actually takes place in three dimensions and should be called *volumnar contraction.*

Cast iron does not contract in a uniform manner from pouring heat until it is cold as it is governed by change in the fluidity of the metal, its chemical composition, and the shape and condition of the mold. The physical condition of the mold refers to whether the mold is green sand, baked sand, or chilled. The chemical condition of the iron refers to the proportion of the metalloids present in the iron. These chemical and physical conditions give three characteristic or cooling types, for example: White iron with silicon, 0.75 per cent, total carbon 2.75 per cent which has but one arrest or retardation. Another type is low phosphorus gray iron with silicon, 3.47 per cent and phosphorus, 0.04 per cent. This type has two arrests. The high phosphorus gray iron containing silicon, 2.98 per cent and phosphorus, 1.25 per cent has three arrests.

Solidification of cast iron in the mold takes place in a series of settings making the progress of solidification continuous, but not uniform. For example, in pouring molten iron in a mold a solid crust of metal first will form at the bottom, top and sides of the mold. The second stage is caused by the deepening or expansion of this solid crust toward the center. The third stage is the solidification of the molten iron at the center of the mold.

TABLE XV

ANALYSES OF REFRACTORIES USED

Silica Brick

	A	B	C	D
Silica	95.50	97.20	95.40	95.95%
Alumina	1.53	1.40	1.70	1.69
Iron oxide	.75	.20	.40	.51
Lime	2.13	.76	2.00	1.20
Magnesia	.11	.35	..	.16

A Harbison-Walker Co., U. S. A.
B General Refractory Co., U. S. A.
C English brick
D German brick
From "General Metallurgy" by H. O. Hofman.

Magnesite Brick

Locality	Magnesia	Lime	Iron and Al oxide	Silica
Styria	85.31	...	9.05	4.70%
Norway	83.60	...	6.60	9.30
Greece	86.50	3.76	6.64	3.10
U. S. A.	93.03	4.20	.72	2.16
U. S. A.	87.66	1.19	9.29	2.05
U. S. A.	90.22	...	8.38	1.38

"General Metallurgy" by H. O. Hofman.

Calcined Dolomite

Silica	1.66	2.50	1.40	3.66
Iron and alumina oxide..	4.80	3.99	3.75	4.80
Lime	56.50	57.32	57.30	55.50
Magnesia	35.83	34.95	37.38	34.83
Loss on ignition	1.06	1.00	.60	1.06

"Metallurgy of Steel" by F. W. Harboard.
"Chemists and Metallurgists Handbook" by Lidell.

Dead Burned Magnesite

Magnesia	89.15	79.20	86.42
Lime	2.30	3.05	1.68
Silica	2.00	10.30	7.00
Iron and Al oxides	5.65	7.10	4.75
Loss on ignition	.15	.35	.15

NOTE:—Analysis does not always show a first class magnesite for furnace purposes. Some natural magnesites, after being burned, show excellent qualities such as low silica and high magnesia, but are of no use for patching due to their lack of bonding qualities. The highest grade material is made by crushing magnesite with iron ore and burning until in a sintered condition. The iron combines with the magnesite to form a refractory which has perfect furnace properties—that of good resistance and fine sintering features. A refractory manufactured in this manner will nearly always show a decided color such as a dark red to brown, or sometimes even a dark steel blue. Light colored magnesite of a white, gray or light brown color will in the majority of cases prove unsatisfactory.

Establish Research

The Carnegie Institute of Technology, Pittsburgh, has established a special research bureau of metallurgy to begin work Sept. 1. The object of this new department is to apply recent discoveries in the fields of physics and chemistry to metallurgical questions. Dr. Francis M. Walters Jr. has been appointed director of the bureau and Dr. Vsevolod N. Krivobok assistant.

The Industrial Works, Bay City, Mich., has opened a district office at 455 Monodnock building, San Francisco, in charge of J. M. McGuire, who has been connected with the Industrial Works for 20 years as construction and erecting engineer.

Good Wood Aids Patternmaker

Careful Selection and Proper Methods of Storing Lumber Are Necessary If Patterns Are to Give Greatest Service—A Study of the Structure of the Wood Shows Best Practice for Gluing

BY WALTER C. EWALT

LONG before the time that the history of mankind first was recorded in writing, the art of making patterns was practiced in connection with the pouring of metals. Relics of people who worked in bronze and later in iron have been brought to us from the Bronze Age of prehistoric times through the discoveries of archaeologists in both the old and new worlds. Scientists state that in the Paleozic Era when sea weeds and the first animals appeared, great beds of copper and iron were formed, and at the same time the organic remains of numberless shell and coral life were formed into limestone, later to become valuable in the melting of iron.

Ages later man appeared. Among his earliest discoveries, that of fire undoubtedly was the greatest, and with it human culture may be said to have begun. It no longer was necessary for him to use crude implements and weapons made of stones or cold wrought metal which he had learned to chip and hammer into shape. He had found that by taking certain substances from the earth, melting them by means of his fire and pouring the liquid metal into holes or deep depressions in the sand or earth, he could produce a hard substance in any shape or form. The stick used to shape the hole in the ground was the first pattern.

Not only beautiful bronze weapons, implements and personal ornaments, but also molds, refuse castings and beds of charcoal and other indications have been found in the old world as evidence of the early efforts in metallurgy. The mound builders of the Mississippi valley are not thought to have been workers in bronze, but they used numerous tools made of copper, which probably were shaped by casting. Later the more civilized Peruvians, as well as the ancient Mexicans, learned to harden copper with tin.

In historic times we read of the perfection attained by the Babylonians in the art of working metals. Examples are known such as the golden image of Bel, which was 40 feet high, the golden table which was 40 feet long and 15 feet wide, and many other objects of the same precious metal, together with the bronze chariots, the city wall with 100 gates made of brass with brazen lintels and posts. Most interesting is the Biblical account of the work of Hiram who fashioned the pillars of brass, the golden and brazen ornaments and utensils for King Solomon's temple. All of these workers must have used patterns of some sort.

At length the smelting the ores of iron was mastered. Few relics of this metal belonging to the early ages have survived, due to its rapid oxidization. However, the few iron weapons and utensils unearthed reveal the habits and intellectual status of the people of this period. Thus for centuries patternmaking has helped to make possible the production of innumerable articles both useful and ornamental.

Although a knowledge of the foregoing is not an absolute essential requirement for a good patternmaker, yet how much more interesting it makes one's occupation to know at least some of the facts concerning its early life.

Today the process of making objects of metal appears simple. The wood patternmaker shapes a block of wood according to a plan or drawing, the resulting object being a pattern. The molder places this pattern in a frame, which is called a flask, and rams sand around the pattern, after which it is withdrawn and the hollow space filled with molten metal.

Wood is the principal object with which the patternmaker works, and to those mechanically inclined, no substance offers as much fascination and interest. We may remark with Douglas Mallock in the *American Lumberman:*

"The men who work in wood—here is a clan,
That other workers well may envy—these,
Who serve so much, so well, their fellow man,
Who turn to use the tall and sheltering trees."

The principal woods used in making patterns are northern white pine and sugar pine of the West. Pine is selected because it holds its shape better and is worked more easily. To make good patterns the wood should be dry, straight grained and free from knots and other defects. Patterns still are in use which have served in hundreds of molds, principally because they were well made from good stock, were used carefully by the molder, and were stored properly and recoated with varnish at the least sign of wear.

While a number of other woods are used in patternmaking, of the soft woods, pine is the best. Only two of the hard woods used will be mentioned, namely baywood, a species of mahogany, and cherry. These woods are much harder than pine and therefore will stand more hard use. Each have characteristics applicable to special kinds of work, the baywood being more easily carved and worked, while the cherry, being harder, lasts longer.

Any wood selected for patterns must be well dried or seasoned before being used. Seasoning the wood, either by natural or artificial means, evaporates the moisture from the cells. As the moisture is driven from the cells, they contract until the moisture in the wood becomes practically the same as that in the surrounding atmosphere. In some shops it is the practice to buy lumber which is known to have been seasoned two years. Upon arrival at the shop it is stacked in an enclosed shelter, the lumber being laid in layers with strips, common lath being suitable, placed between the layers so that the air may circulate through the stack. The strips also keep the lumber straight across grain as well as lengthwise. The lumber is kept in this way for a year and then is placed in a dry kiln where it is subjected to a temperature of 90 to 125 degrees Fahr. for from three to four weeks. The lumber is cut in 8-foot lengths upon removal from the kiln and is stood on end in the pattern shop.

Looking at the end of a board one notices circular markings. These rings are caused by the yearly growth of the tree and are called annular rings. The wood is made up of bundles of long cells or fibers and crossing the fibers in a radial direction from the pith to the bark are the medullary rays which bind the whole together. The medullary rays greatly affect the wood and it is in the direction of these rays that the end of the log generally cracks when dried out. To prevent this the ends of the log should be painted.

A board cut as in Fig. 1 will remain fairly straight, but one cut as shown in Fig. 2 will warp as shown in Fig. 3. It is exceptionally difficult to

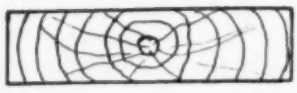


Fig. 1

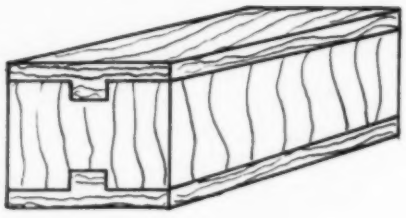


Fig. 5

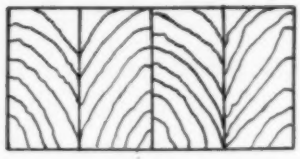


Fig. 9

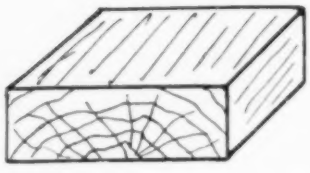
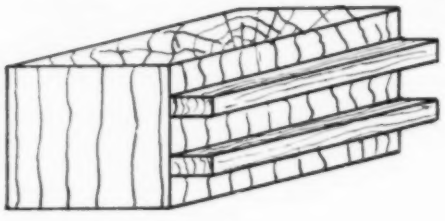


Fig 2



Parting

Fig. 6

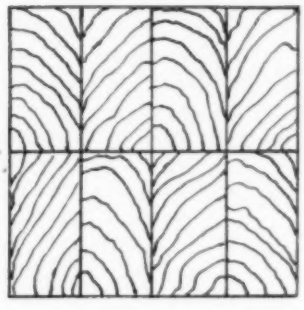


Fig. 10

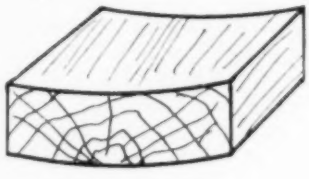


Fig 3

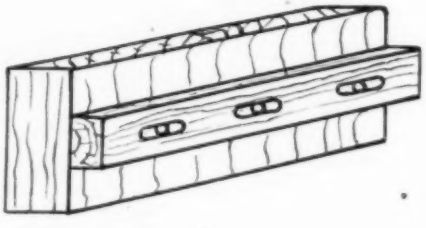
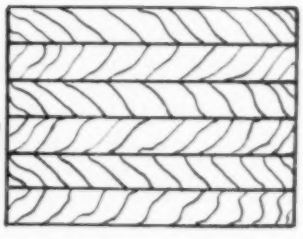


Fig. 7



Parting

Fig. 11

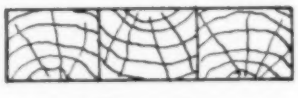


Fig. 8

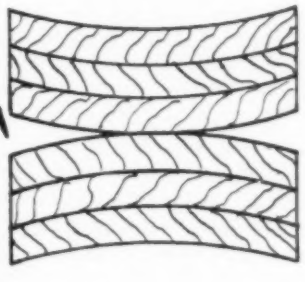


Fig. 12

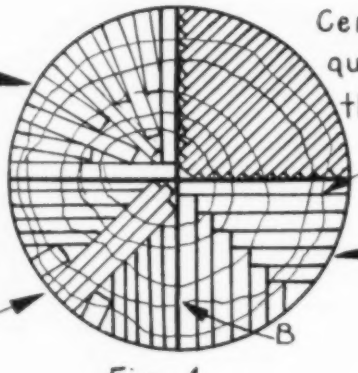

Best looking but wasteful
Center pieces quarter Sawed the rest bastard
A
"A" and "B" Quarter Sawed
Not so wasteful and generally the way high grade lumber is cut
B

Fig. 4.
Quarter Sawed

FIG. 1—LUMBER CUT IN THIS MANNER WARPS ONLY SLIGHTLY FIG. 2 AND 3—STRUCTURE OF WOOD CAUSES WARPING FIG. 4—QUARTER SAWING FIGS. 5, 6 AND 7—VARIOUS METHODS USED IN KEEPING BOARDS STRAIGHT FIGS. 8, 9 AND 10—PROPER METHODS OF ARRANGING WOOD FOR GLUING FIGS. 11 AND 12—WRONG METHOD OF GLUING WOOD

keep a single board straight, especially one having a thin section. For this reason it is better to save lumber that is quarter sawed, that wood which has been cut at right angles to the annular rings, since it will hold its shape better and will be more satisfactory for special work. Various ways for quarter sawing lumber is shown in Fig. 4. Various other methods are used to keep boards straight as are shown in Figs. 5, 6 and 7. Often to overcome warping, pieces are glued together, the alternate pieces being reversed, thus causing each piece to become a check on the one next to it, as shown in Fig. 8. When gluing large pieces, the wood should be laid with the grain arranged as shown in Fig. 9. The best method for gluing stock which is to be turned and made in halves is shown in Fig. 10. The wood will hold its shape better than if glued as shown in Fig. 11 as it may warp as shown in Fig. 12.

Simplify Making of a Simple Pattern

BY J. W. BROADBENT

WHILE the great variety of work in some shops affords an ample opportunity for the patternmaker to become versatile; in many other foundries the castings produced are confined to a few particular types and his experience is limited. When the scope of practice is small, mistakes often result in making patterns for a new type of casting, which could be avoided if the patternmaker had a better understanding of the requirements of the job. An example of the trouble that may arise was shown recently when a pattern was sent to a malleable iron foundry with an order for 5000 pieces. The specifications called for one face, *A* shown in Fig. 1, to be flat and smooth. The square hole, also shown in Fig. 1, was to be true and smooth.

No doubt the pattern had been made by a workman experienced in making many types of patterns, but the one provided in this case was considered useless, even for a small number of castings, by the foundry making the job. The pattern as furnished is shown in Fig. 2. Ten wooden patterns were mounted on a wooden plate, one side of the plate being flat and the other side rather irregular. The runner and gates were nailed on the drag side and were made from ⅝-inch dowels placed in a semicircular shape. Upon receipt of the patterns at the foundry, the gates were pared a little at the point where they joined the pattern, but even then they were far too thick for the size of the job.

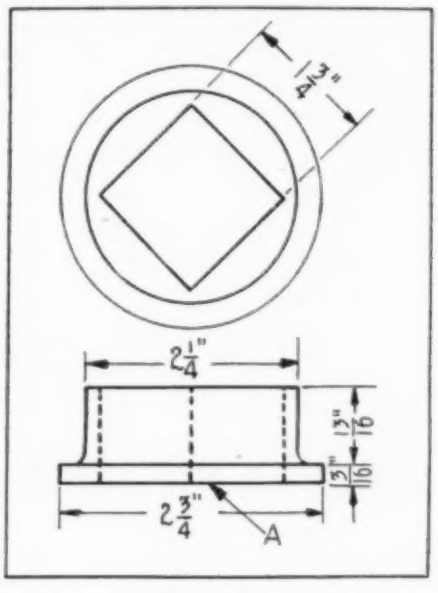


FIG. 1—SKETCH OF THE CASTING

The corebox sent was a great puzzle as far as usefulness was concerned. The box consisted of five cores joined by a slab core on the top, the slab being 1⅛ inches thick. No doubt the patternmaker expected that this core would be used to form the flat surface required on the face of the casting, since two of these cores placed together would close the mold entirely. No provision was made for pouring the metal through the cores into the mold. A doubt existed as to whether it was intended to form the cover of the mold with the core or whether a cope was to be rammed over the cores. Not only would it have been extremely difficult to set these cores, but an excess amount of core sand was necessary, thus increasing the cost of the job.

To put the pattern in working shape, the patterns, gates and runners were removed from the plate. The gates and runners were scrapped and the plate planed to a uniform thickness. The plate was cut down to mold in a 10 x 18-inch flask. Flask pin guides were attached to the end of the pattern and the centers of the patterns were brought nearer together. The centers were located on the other side of the plate and core prints, the same size as those on the pattern were attached so that the

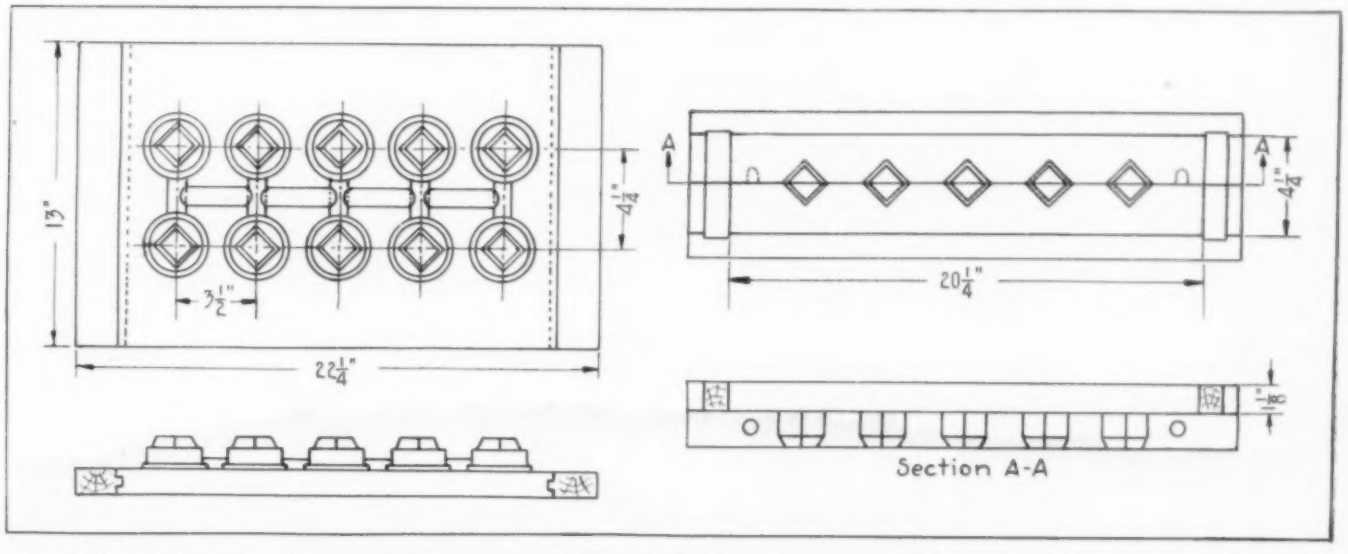


FIG. 2—LEFT—TEN PATTERNS WERE ARRANGED ON THE PLATE AND GATES WERE ATTACHED—RIGHT—THE COREBOX, AS FURNISHED WAS EXTREMELY COMPLICATED

square hole would be cut through the casting. Suitable gates were put on the pattern side of the plate and the runner and feed balls were placed on the cope side. This is the usual practice for malleable iron, the runner helping to feed the castings.

A corebox of hard wood and containing two cores was made. The green sand cope formed as smooth a face as dry sand would have done and the resulting castings were up to requirements and were produced at a less cost than would have been possible with the patterns sent.

Care Necessary in Taking Roll Samples

WITH the constantly increasing importance attached to the chemical analysis of rolls, all operators should use utmost precaution in obtaining the sample correctly so that all possible causes of error which might be traced to mechanical slips, may be eliminated, says *United Effort*, a publication of the United Engineering & Foundry Co., Pittsburgh. An improperly gathered sample will produce an improper analysis even before the chemist weighs the amounts for determinations. Dirt, grease, sand, scale, blacking, or facing when placed in the sample cause losses or gains in graphite, mechanical errors that should be avoided. Large, coarse turnings that require special manipulation by the chemist cause unnecessary error. Turnings should be supplied that may be crumbled easily between the fingers.

The position on the roll from which the sample is taken also is important. For example, a test made from the drillings obtained by centering the drag end introduces an error since some of the facing is sure to get into the sample, thus producing the wrong carbon result. This position on the roll sometimes is chilled, wholly or partly, which ultimately affects the quantity of carbon classed as combined. When molten iron and steel cool slowly, segregation occurs, that is the various elements such as silicon, sulphur, manganese, phosphorus, etc. are present in different proportions at various levels or depths of the casting. Since segregation means a breaking away from the average, it is seen that the analysis will vary from the center out and from the bottom to the top. Consequently, at no position may samples be obtained that will give check results in every detail. The spot where the least segregation occurs should be selected and this spot used at all times. This method gives uniform practice for all castings of the same shape and should be adhered to at all times.

The United Engineering & Foundry Co., would prefer that the sample be taken on the bottom neck about 1 inch away from the gate in the direction of the cope end of the roll, using a flat tool 3 to 4 inches wide. The roll turner is instructed to cut the surface clean and to wait until the band is cut to approximately the proper neck diameter before gathering the sample. The tool should be jammed just enough to produce a fine cut so that at least one or two revolutions are required before sufficient sample is obtained. Care must be taken in transferring the turnings to the sample envelope for at this point much carbon may be lost by lifting the coarser particles and leaving the fine. The tool should be clean at the start and when the sample is transferred every particle should be placed in the sample container. The best method is to stop the lathe when the tool is full, although not always possible, when peaks of production are reached.

Since the quality of the roll frequently depends on the analysis, it readily may be seen that great care should be taken. True analyses not only are an aid in determining the quality, but they give the metallurgist an idea on the proper treatment of the mixtures being used. This reason alone is worth the extra time and resulting cost necessary in obtaining good samples. It is for this reason that samples should be taken from defective rolls with as much care as is exercised in good ones. It is the only real clue that the metallurgist may have to determine the cause of the trouble. Furthermore, the defective roll must be remelted and unless an analysis is made, a guess analysis must be made before mixture may be figured. This might result in the same conditions as were encountered before.

Form New Company for Engineering Service

The Watson Engineering Co., 15 Park row, New York City, recently was organized as a partnership and consists of the following members: Wilbur J. Watson, president of the Watson Co., Cleveland, and consulting engineer of the Dock & Terminal Engineering Co. of that city; Charles D. Watson, formerly New York vice president and eastern manager for the Watson Co., Cleveland; and Stanley H. Chadwick, formerly associated with the H. D. Best Co., New York.

The new organization will perform engineering services for all classes of industrial plant work. It is affiliated with the Watson Co. of Cleveland and also will act as the eastern representative of the latter company and for the Dock & Terminal Engineering Co. Stanley H. Chadwick will specialize in foundry work. For a period of nine years he was associated with the H. D. Best Co. and prior to that time for a period of six years he was affiliated with George K. Hooper, foundry engineer of New York City.

Mixture for Cast Iron Ingot Molds

By George A. Drysdale

Question: We have an inquiry for making a number of cast-iron, ingot molds for brass ingots, the dimensions being as follows: 3 x 5 x 5 inches with 1 inch thickness of metal. What is the best mixture to use for this class of work, as we wish to be sure that the castings will not be liable to fracture on cooling?

Answer: Cast-iron, ingot molds are best made from soft, low phosphorus pig iron with a suitable proportion of soft scrap, usually 60 per cent pig iron and 40 per cent scrap.

The chemical analysis of a satisfactory ingot iron is approximately as follows:

	Per cent
Silicon	2.25
Sulphur	0.076
Phosphorus	0.30
Manganese	0.50
Combined carbon	0.13
Graphite carbon	3.17
Total carbon	3.30

In making the cupola mixture to give results in the casting such as are tabulated, allow the following loss and gain in the metalloids when melting mixture in a cupola furnace: Silicon loss from 0.15 to 0.20 per cent by oxidation; sulphur gain from 0.20 to 0.045 per cent, amount absorbed from the fuel; manganese loss from 0.20 to 0.30 per cent; phosphorus remains approximately neutral.

Made Company President

M. A. Bell, recently connected with the E. J. Woodison Co., Detroit, as sales manager, now is president of the Independent Foundry Supply Co., St. Louis, dealer in foundry, platers' and polishers' supplies.

Milestones in Foundry Progress

As Recorded in the August Issues of THE FOUNDRY, Thirty, Twenty and Ten Years Ago

ALL hail! then, to the molder,
The primal iron trade
And on whose head the crown should be
With jewels that never fade
C. A. BURTON.

Thus was the August, 1894 issue of THE FOUNDRY *opened with song.*

* * *

Many can testify that the "hail" heaped upon the molder's head not always is spelled that way.

* * *

Como in his column, The Kranks Korner, assails the existence of Santa Claus in these pointed words.

It has been a wonder to me that the individual who is always melting iron in the neighborhood of 1 fuel to 12 and 14 does not take a tumble and specify the class of castings he is turning out. He has gone unmolested and through a sort of senatorial courtesy * * * has not been disputed. It therefore has become about time that his stories generally are regarded as being of the fishy or snaky type. * * * we do not believe it is done on this earth.

* * *

Samuel Lord was tendered a silver tea service on completion of 25 years service as foreman of the Great Western Stove Co., Leavenworth, Kan.

* * *

Foundry operations were improved over July. No. 1 foundry iron was quoted at $11.25 to $11.50, Pittsburgh.

* * *

W. Edwards, continuing the history of a common man told how he and his molder companion stranded in the South, sawed wood for six bits a cord, cleared $3 over expenses in two weeks, and were frightened out of the vicinity of Hollywood, Miss., by night prowling panthers, bears and other beasts.

* * *

This is probably the earliest recorded bear story emanating from Hollywood and concerned with the night life of the wild inhabitants of that region. Yes! the climate also was mentioned.

* * *

The new plant of Bridge & Beach Mfg. Co., St. Louis, was approaching completion.

Faked Foundry Facts

A Coke Bed

J. J. Ryan & Co., 68-74 Monroe street, Chicago, cast three aluminum bronze gears weighing 1000 pounds each.

* * *

A core boy sent by the foreman to bring in the hungriest looking molder in the line waiting at the gate for a job, admitted the whole gang.

* * *

Black & Clawson Co., Hamilton, O., cast a seamless paper drying cylinder 36 inches in diameter with a 160-inch face. Charles Coomes was foreman.

THE subject of apprentice training was engaging editorial attention and was the center of interest among the technical and commercial organizations. The Carnegie technical school, then being established in Pittsburgh, expected to devote special courses to foundry instruction.

* * *

Standard Methods for Making Beds

* * *

Wrong again! This was not a pamphlet for hotel managers, nor a discussion from the annual meeting of furniture manufacturers in Grand Rapids. Merely the editors *naive* way of heading a paper by Thomas D. West, read at the meeting of the American Foundrymen's association.

General Electric Co., Schenectady, N. Y., had completed a new brass foundry in that city which was fully described in the August issue of THE FOUNDRY.

* * *

No. 2 southern pig iron was quoted at $9 furnace, against a central western price of $11.75, while production had fallen to an annual rate of 15,700,000 tons in June with further reductions in July.

* * *

Contracts for tunnel segments for the Pennsylvania tunnel were reported awarded to the Wheeling Mold & Foundry Co., and Davies & Thomas Co., Catasauqua, Pa. The job totaled 57,000 tons.

* * *

Walter Wood, chairman of Committee B of the American Society for Testing Materials, offered specifications for foundry iron, pipe and specialties, locomotive cylinders, car wheels, malleable and gray iron castings at a meeting of that organization in Atlantic City. Dr. Moldenke reported that European foundries used oxide of manganese with a basic flux to reduce sulphur.

AT THE start of August, 1914, the month which marked the beginning of the World war, foundries were operating below capacity throughout the country. Railroads were just starting to place orders for cars, held in abeyance for about six months. No. 2 pig iron was selling in Birmingham for $10 *to* $10.25 *and in Chicago for* $14 *a ton. Open-hearth steel castings had surpassed all previous records, reaching* 910,216 *tons with basic leading in* 1913. *It will be recalled that last year recorded* 1,152,609 *tons of open-hearth steel castings, with acid practice favored.*

* * *

S. V. Blair, president of the Associated Foundry Foremen, in a paper before the Southern Michigan

(*Concluded on page* 619)

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Seek Lower Sand Rates

PIG iron purchased at a certain price at the furnace is delivered to the foundryman at a fixed rate per ton for freight. No questions are asked as to whether the iron is designated for 2-ounce castings or for counter weighting a bascule bridge. The freight rate is based upon weight and distance hauled alone. Consider the inconsistency of the rates asked by railroads for transporting sand. Here too, the foundryman pays the freight, for sand, like iron, is sold f.o.b. the quarry or pit. The sand producer may load a car for one customer which takes a much higher rate than that loaded immediately before for another user and from the same pile, for the railroad asks, "For what purpose is this sand intended." The freight rate is assessed upon the use for which the sand is destined. Road gravel, building sand and molding sand all take different rates and the last mentioned is the highest. The American Sand association recently carried the question of molding sand rates to the central freight association general committee contending that an unfair discrimination was made against the foundry interests. This contention was denied. If relief is found it must be through a complaint filed with the interstate commerce commission. The sand association is a small organization of limited means and accordingly the cooperation of interested foundry organizations and individual castings manufacturers is sought. The secretary of the sand association is Hubert B. Fuller, Guardian building, Cleveland.

Encroach on Gray Iron Field

WHY should gray iron continue to be the Cinderella of casting metals? Steel and malleable castings are the favored sisters, eagerly sought after, while gray iron is shoved still further into the chimney corner by forgings, stampings and a multiplicity of formed metal parts.

Specifications exist applying to gray iron castings, but these seldom are consulted either by buyer or seller. The consumer asks only sound metal, soft enough to forestall a wail from the machine shop, except in rare cases where the iron foundry is a part of the main manufacturing plant, when other requirements may be applied. In consequence, foundries making gray-iron castings are confronted by a condition similar to that which was met by malleable shops many years ago. Declining demand is noted and the encroachments of other products is causing concern among the gray iron jobbing interests.

The remedy lies largely with the foundries themselves. When gray iron castings can be offered subject to specification and capable of meeting the requirements of standard strength and shock resistance, increased demand will follow. Only a few years ago, malleable castings were in poor character. The formation of a strong organization which backed specification requirements and enforced tensile and elongation minimums drew attention to the character of malleable castings and increased their sales. A similar movement resulted favorably for makers of steel castings.

Obviously, gray iron never can hope to attain the high standards set either by malleable or steel, but its field of usefullness may be extended and the demand for iron castings cultivated by knowing more of the metal and what it should be. Then advertise it.

Trade Outlook in the Foundry Industry

WHILE no decided upturn is noted in foundry activity at the end of July, a better feeling is prevalent as reflected in the purchase of materials and equipment, and patterns. Castings orders are few, inquiry has fallen away and except in a few instances, operations have been reduced to a minimum throughout the month. A few notable exceptions are found among shops making special high grade castings or among those which have established a reputation for short time delivery on urgently needed parts. One steel foundry in northern Ohio is working practically full time on castings which may be characterized under the class of immediate orders.

Steel Shops Slow

The plant mentioned constitutes an exception, for in general the demand for steel castings has dropped to a minimum on a descending curve starting with the close of March. According to the department of commerce, the booking of steel castings tabulated from the reports of 70 identical companies show June to have fallen to 48.4 per cent of the listed capacity of the plants reporting. This compares with bookings of 56.2 per cent of capacity for May and 67.3 per cent for April. Railway specialty shops have been the more fortunate, for their orders stood at 67 per cent of capacity in June, 71.8 per cent in May and 84.9 per cent in April. This gives indication of the source of much of the castings demand, although railway buying has not been active for several months. Preparations are being made by the railways for heavy autumn shipments. A decrease is shown in the total number of locomotives needing repairs while an increase in the number put into condition for service is noted with the passing of each successive month. Car repair work also has declined.

Prices for Raw Materials for Foundry Use

CORRECTED TO JULY 23

Iron		Scrap	
No. 2 Foundry, Valley	$19.00 to 19.50	Heavy melting steel, Valley	$18.00 to 18.50
No. 2 Southern, Birmingham	18.00 to 18.50	Heavy melting steel, Pitts.	18.00
NO 2 Foundry, Chicago	19.50 to 20.00	Heavy melting steel, Chicago	15.25 to 15.75
No. 2 Foundry, Philadelphia	20.76 to 21.76	Stove plate, Chicago	16.00 to 16.50
No. 2 Foundry, Buffalo	19.00	No. 1 cast, Chicago	19.00 to 19.50
Basic, Valley	19.00	No. 1 cast, Philadelphia	17.50 to 18.50
Basic, Buffalo	18.50 to 19.00	No. 1 cast, Birmingham	15.00 to 16.00
Malleable, Chicago	19.50 to 20.00	No. 1 cast, Buffalo	16.00 to 16.50
Malleable, Buffalo	19.00 to 19.50	Car wheels, iron, Pittsburgh	17.00 to 17.50
Coke		Car wheels, iron, Chicago	16.50 to 17.00
Connellsville foundry, coke	$4.00 to 4.50	Railroad malleable, Chicago	17.00 to 17.50
Wise county foundry, coke	4.50 to 5.00	Agricultural mal., Chicago	16.50 to 17.00
		Malleable, Buffalo	17.50 to 18.00

Ohio Holds Pace

According to a report of the Ohio State Foundrymen's association, foundries in that state are maintaining a fair standard of activity. For June, the melt declined slightly, but was recorded as 72 per cent of normal. The preceding month registered 75 per cent. Stocks of materials on hand, including pig iron, all grades of nonferrous metals and scrap totaled 87 per cent of the normal melt. In May this figure stood at 82 per cent. This furnishes an indication of the tendency of foundries to anticipate slightly in advance of their immediate needs. The stocks received in June stood at 51 per cent of the normal melt. The decrease in automotive demand has pulled down the rate of operation in Ohio, Michigan, Wisconsin and to a certain extent in Indiana and Illinois. In New York part time employment in manufacturing plants is general and is most marked in the foundry, locomotive and railway repair shops. Building construction continues at a fair rate and serves to bolster up demand for miscellaneous domestic castings.

Building Increases

In practically all sections of the country, building construction is increasing. In Chicago, building permits in June practically doubled those taken out in June last year, and except for a high record in June, 1922, eclipsed all previous records for the same month. That city's building for the first six months of this year stands second since the records first were made ten years ago. In addition to the essential lines of plumbing castings, soil pipe, radiator and furnace needs, this increase in building construction carries a corollary of increased demand for castings, coming indirectly through the long list of domestic machinery, such as washers, ironers, fans, refrigerators and the miscellaneous conveniences, now practically in the necessity classification. An indication of the importance of the secondary source of demand is noted among electrical firms. Orders received by the General Electric Co., for the first six months of the year were only 12 per cent below last year. Malleable operations have dropped to about 30 per cent of capacity, although the railway specialty shops are slightly ahead of this figure. Some furnace manufacturing establishments are operating full time, while others have encountered a decline in orders. One of the best indications of an early return of normal operation in practically all foundry lines is offered by reports from pattern making firms which report a heavy demand, especially for new or experimental work. This normally precedes a return of foundry activity by 60 days, according to the experience of older pattern makers. Cast iron pipe business in the South is improving, while orders are on hand to assure operation through the third quarter of the year. Pipe shops already have completed six months of exceptionally good business and the tonnage production for the year is expected to exceed 1923 by a comfortable margin. One point of encouragement to jobbing foundry interests is the discontinuance of operations in a few of the large high cost foundry departments of manufacturing establishments which are buying their castings outside rather than carry the added burden of high overhead incident to part time production. The National Purchasing Agents association notes an upturn in coal buying.

Nonferrous Prices

Nonferrous prices in New York, according to the *Daily Metal Trade* of July 23 follow: Casting copper, 12.50c to 12.62½c; electrolytic copper, 12.75c to 12.87½c; lead, 7.10c to 7.15c; Straits tin, 49.00c; antimony, 8.37½c to 8.50c; aluminum, No. 12 alloy, open market, 21.00c; nickel, 30.00c. Zinc is 5.95c, E. St. Louis, Ill.

Comings and Goings of Foundrymen

ROBERT J. ANDERSON resigned recently as metallurgical engineer with the United States bureau of mines experiment station, Pittsburgh, and now is doing research work on aluminum alloys and radiology of metals in connection with graduate work at the Massachusetts Institute of Technology, Cambridge, Mass. He also is acting in the capacity of consulting metallurgical engineer with offices in Boston. Mr. Anderson was born at Cleveland, July 10, 1892. He attended the public schools and was graduated from the Case School of Applied Science, Cleveland, in 1914, receiving the degree of metallurgical esgineer from that school in 1917. From 1914-15 he was assistant superintendent of the Jno. Moore & Son, Cleveland. In 1915-16 he was instructor in metallurgy at the Missouri School of Mines, Rolla, Mo., also acting as research metallurgist in the Missouri state mining experiment station. He went with the American Rolling Mill Co., Middletown, O., as metallurgical engineer in 1916, later becoming assistant to Dr. H. M. Howe, Bedford Hills, N. Y. He assisted in setting up a laboratory when Dr. Howe moved from Columbia university. In 1917 he became chief chemist and metallurgist at the Cleveland Metal Products Co., Cleveland, and a year later he accepted a position as aeronautical engineer with the bureau of aircraft production, Washington. From 1919 to 1924 he has been connected with the bureau of mines experiment station, Pittsburgh, where he was in charge of the nonferrous metals section. Since 1916 Mr. Anderson has written many technical articles which have been published in various scientific journals and business papers. He is a member of the American Foundrymen's association, the American Society for Testing Materials, the American Institute of Mining and Metallurgical Engineers, the Society for the Promotion of Engineering Education, the Franklin institute, the American Society for the Advancement of Science and the British Institute of Metals. He is serving on a number of committees in connection with these societies.

John H. Moffett, instructor in foundry practice at the University of Minnesota, is employed during the summer in Cincinnati. Mr. Moffett served his apprenticeship at Madden & Co., Rushville, Ind., later working as a journeyman molder at Arbuckle & Co., Rushville. From 1911 to 1915 and again from 1920 to 1921, he was a student at the University of Cincinnati. He became connected with the University of Minnesota in 1921.

C. W. Squires, Malleable Castings, Ltd., Sidney, Australia, is making a short inspection tour of the United States, covering representative malleable casting centers and visiting various establishments.

Give Farewell Dinner

Representative foundrymen of Great Britain, attending the International Foundry Trades exhibition at Birmingham, England, tendered a farewell dinner on Thursday, July 1, to H. Cole Estep, European manager of THE FOUNDRY, who is returning to America soon. The dinner was organized by H. Roe and W. O'Keefe and was presided over by F. J. Cook, ex-president of the Institute of British Foundrymen. Mr. Cook stated that the guest of the evening largely had been responsible for inaugurating the excellent system of international exchange papers, not only between the American Foundrymen's association and the Institute of British Foundrymen, but also between many of the other national foundry technical societies. E. Ronceray, on behalf of the Association Technique de Founderie, thanked Mr. Estep for his contribution to the success of the International Foundry congress held in Paris last September. Mr. Cook presented Mr. Estep with a silver cigarette case and a silver cigarette box, both suitably inscribed, as a token of the respect in which he is held by British foundrymen.

ROBERT J. ANDERSON

Among others present were R. Buchanan, first president of the Institute of British Foundrymen; E. Ronceray; F. J. Barradell, Blackfriars Foundry Requisite Co.; London, J. E. Fletcher, consultant of the British Cast Iron Research association; V. C. Faulkner, editor of the *Foundry Trade Journal*, London; J. Horton, British correspondent of THE FOUNDRY, Cleveland; P. J. Jump, Hingley & Sons, Ltd.; W. O'Keefe, Adaptable Molding Machine Co.; I. E. Lester, ex-president Staffordshire Iron & Steel institute; A. Marks, Harper, Sons & Bean, Ltd.; J. G. Pearce, director of the British Cast Iron Research association; P. Pritchard, Midland Motor Cylinder Co., Ltd.; H. J. Roe, secretary, Birmingham branch of the Institute of British Foundrymen; C. Retallack, John Harper & Co., and D. H. Wood, senior vice president, Birmingham branch of the Institute of British Foundrymen.

Summer Outing Held by Eastern Foundrymen

Four eastern foundrymen's association joined July 16 in a summer outing at Nantasket, Mass., which it is hoped will develop into an annual institution. The associations represented were the Philadelphia Foundrymen's association, the Newark Foundrymen's association of Newark, N. J., the Connecticut Foundrymen's association, with headquarters at Hartford, Conn., and the New England Foundrymen's association of Boston.

In January by coincidence the Philadelphia, Newark and New England foundrymen's associations all held their annual meetings on the same night and telegrams were exchanged during the evening in a spirit of friendliness and co-operation. The ground work then was laid for closer contact in the work of the different associations.

The recent gathering at Nantasket, while essentially of an outing character, nevertheless offered opportunity for business discussion which dealt chiefly with uniform costs. Norman Russell, president of the New England Foundrymen's association opened the session by pointing out the common interests of eastern foundrymen and by voicing a hope that cooperation among the various associations

could be secured. J. L. Carter, president of the Newark Foundrymen's association told of the progress made in uniform cost systems in and around Newark. He said that the majority of the foundries have joined a scheme of keeping co-operative standard costs. This was accomplished by having one man, an expert in his line, control the cost accounting of all the foundries in the group.

Fred Stickle, president of the Connecticut Foundrymen's association told about the problems and working arrangement now in effect in the Hartford territory. To have a basis for standardizing costs throughout the entire eastern foundry field, it was voted that the different associations appoint members to a joint committee to work out plans and method of procedure.

Nearly 150 foundrymen left Boston by boat for the shore dinner which was served at Nantasket. The meeting was followed by sports of various kinds and informal group discussion. The Providence Gas Co. invited all those present to joint in its complimentary outing to foundrymen which will be held at Providence in August.

Prominent Engineer Dies

Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and prominent for many years in the engineering profession, died at his home in Pittsburgh on July 8. He was born near Springfield, O., in 1864 and was educated in county schools in that vicinity. He was graduated from Ohio State university, Columbus, O., in 1888, and in May 1889 entered the employ of the Westinghouse company in its testing department. In 1900 he was made assistant chief engineer, succeeding to the position of chief engineer in 1903. Mr. Lamme was recognized as an important contributor to electrical progress, having been a leader in developing alternating current apparatus and having to his credit over 100 major patents covering electrical equipment. In 1919 he was awarded the Edison medal for that year by the American Institute of Electrical Engineers, in recognition of his many contributions and inventions. Mr. Lamme was appointed by the secretary of the navy in 1915 as a member of the naval advisory board, where he rendered valuable service. He was recommended to the government by the American Institute of Electrical Engineers, after a careful survey of its membership. In 1917 he was elected chairman of the inventions committee of the naval consulting board.

Contest Basis of Fixing Freight on Sand

Sand is sand is the contention of the American Sand association which recently filed a complaint before the general committee of the central freight association in the interests of producers and users of sand. According to prevailing practice the use for which sand is destined forms the basis for fixing freight rates and molding sand is assessed more than material which is intended for construction use. Foundries usually buy their sand at a fixed price at the pit or quarry, and accordingly suffer from the additional rate on this commodity.

The American Sand association, through its secretary, Hubert B. Fuller, Guardian building, Cleveland, filed a brief with the association representing the railroads in the central states. This brief pointed out the discrimination between the various producers and the prejudicial charge assessed against consumers of sand-blast, loam, molding and silica sands. Precedent against this practice was cited showing the public utilities commission of Ohio decided in 1914 that all sand should take the same rate and that carriers have no right to dictate the use to which a commodity shall be put. A comparison was drawn to show that the ultimate use played no part in the rates on lumber, pig iron, semi-finished and finished steel and other commodities and that establishing a scale of rates based upon destined use was discriminatory.

The railways have declined to agree with the contention of the American Sand association, and accordingly the latter organization contemplates filing suit with the interstate commerce commission asking relief.

Obituary

Conrad Christian Arensberg, president and director of the McCullough-Dalzell Crucible Co., Pittsburgh, died July 18 at his home there after having been ill with bronchial pneumonia for several weeks. Mr. Arensberg was one of the oldest manufacturers of crucibles for steel plants and foundries in the United States. He was born in Pittsburgh, Aug. 17, 1840. In 1872, he, in association with John and Willis Dalzell and Michael McCullough organized the McCullough-Dalzell Crucible Co. At the outbreak of the Civil war he enlisted in Hampton's independent battery F., Pennsylvania light artillery, with which he served continuously until severely wounded at Boonsboro, Md., a few days after the battle of Gettysburg.

Grant Hubley, vice president and director of the Oil Well Supply Co., Oil City, Pa., and Pittsburgh, died early Saturday morning, July 19 at the Homeopathic hospital, Pittsburgh, as the result of injuries received June 30 when he was struct by an automobile.

May Purchase Plant

Further steps by the Replogle Steel Co., in the acquisition of cast-iron, pipe manufacturing properties are indicated by reliable reports that it is negotiating for an option to buy the Donaldson Iron Co., Emaus, Pa. As in the case of the Warren Foundry & Pipe Co., upon which the Replogle interests recently have acquired an option, the Donaldson Iron Co. is an eastern concern of many years standing. It is estimated that it has a normal capacity of about 150 tons daily, or around 50,000 tons a year.

Should these two properties be acquired they would afford the Replogle interests an outlet of 450 tons for the pig iron production of its two furnaces at Wharton, N. J., which have a capacity of about 500 per day each. It is understood that plans for acquiring still further properties are contemplated.

Milestones in Foundry Progress

(*Concluded from Page* 615)

Foundrymen's association, recommended flaring, fan-shaped gates for stove plate work.

* * *

R. E. Kennedy, at present assistant secretary of the American Foundrymen's association, collaborating with J. C. Pendleton, described economy production on small castings involving a combination core and green sand molding process.

* * *

Proposed international specifications for cast iron were presented. The movement to adopt these specifications was interrupted by the war. An arbitration bar 1.2 inches (30 millimeters) in diameter and 20 inches (50 centimeters) long cast vertically in dry sand molds was suggested.

* * *

Dr. H. W. Gillett, bureau of mines, had just published a bulletin on brass foundry losses in which he stated that to reduce the total losses to the best average practice would result in saving over a million and a half dollars a year.

The New Jersey Zinc Co., New York, is building a rolling mill at Palmerton, Pa., for rolling zinc sheets. It is expected that this company soon will be a large producer of corrugated and plain zinc sheets.

Equipment Buying Lull Holds

Volume of Sales During Past Month Has Been Exceptionally Light—Reports from Many Manufacturers Indicate a Fair Business for the First Half of the Year

LITTLE improvement in demand has been noted in the various distributing centers for foundry equipment during the past two weeks. In the main, buyers are holding off orders for machines and are allowing inquiries now out to lie dormant, evidently waiting for better conditions in the foundry industry. Construction of new plants is being held up and inquiries for equipment are scarce. However, reports from several companies making foundry equipment show that fairly good business was realized for the first six months of the year. In fact the volume of sales for several concerns exceeded that for the corresponding period in 1923. Manufacturers are not discouraged by the present lack of activity which they consider temporary, and many feel the upturn is in evidence.

The Herman Pneumatic Machine Co., Zelienople, Pa., has disposed of a number of machines, two each being sold to the Minneapolis Threshing Machine Co., Hopkins, Minn., and the Michigan Steel Casting Co., Detroit, and one to the Southern Manganese Steel Co., St. Louis. The W. W. Sly Mfg. Co., Cleveland, has sold equipment to various automobile manufacturers in the Detroit district, as has the Pangborn Corp., Hagerstown, Md.

Automobile Shops Make Purchases

HALTING sales of foundry equipment are characteristic of the Pittsburgh area. One seller states that June sales only were half as large as they were in March. A few here and there buy needed supplies but there is no volume to the demand for shovels, wheelbarrows, riddles and kindred equipment. A few crucibles continue to be sold from time to time and the trade still is engaged upon the inquiry for a large core oven from an Ohio foundry, as referred to in the July 15 issue. The buyer has decided not to purchase second hand equipment, but has cut down the size of the oven a trifle and now is taking bids on the complete job installed. The Standard Sanitary Mfg. Co., still is negotiating for a cupola and one or two foundries want sand mixing equipment. The Osborn Machine Co., Du Bois, Pa., recently purchased a sand mixer from the Blystone Mfg. Co., Cambridge Springs, Pa., as did the Canton Malleable Iron Co., Canton, O. The Hughes Tool Co., Houston, Tex., which recently inquired for four large molding machines has purchased three from the Herman Pneumatic Machine Co., Zelienople, Pa., and this same manufacturer has sold several other machines. Many other molding machine inquiries are hanging fire, including one from a new Jersey City, N. J., foundry. The Atlantic Coast Line railroad has been inquiring for some foundry equipment of various kinds for the foundry it operates and some of this will be closed shortly. The Wayne Iron Works, St. David's, Pa., is putting up a new plant and it is understood that some equipment is to be bought by its Philadelphia office. The Westinghouse Electric & Mfg. Co. continues as a steady buyer of foundry equipment and other machinery as needed at various plants. The Westinghouse Airbrake Co., Wilmerding, Pa., has not started on its buying program as yet, which it is believed will be quite extensive. The Ross-Meehan Foundry Co., Chattanooga, Tenn., is buying equipment for an addition to its plant, the general contract for which was awarded the Converse Bridge Co. The W. W. Sly Mfg. Co., Cleveland, has sold a tumbling mill installation to the March Brownback Stove Co., Pottstown, Pa. and a blast pressure tank to the Westinghouse Electric & Mfg. Co., Sharon, Pa.

In the crane market, foundries lately have purchased little although a number of inquiries are pending, including the Parkersburg Machine Co., Parkersburg, W. Va., a 5-ton; and the United States Radiator Co., Corry, Pa., one 5 or 10-ton crane. The Westinghouse Electric & Mfg. Co., recently has bought a 10-ton, 4-motor, 48-foot span electric traveling crane from the Morgan Engineering Co., Alliance, O.

Some Inquiry Noted

WHILE some increase is noted in the purchase of supplies and raw materials on the part of New England foundries, the equipment market practically has been at a standstill during the last two weeks. Contract for a new modern foundry has been let by the Rhode Island Malleable Iron Co., Hillsgrove, R. I., and buying of considerable equipment in this connection is in prospect. The W. W. Sly Mfg. Co., Cleveland, has sold dust arrester and spark arrester equipment to the H. & B. American Machine Co., Pawtucket, R. I. A western Massachusetts foundry bought several molding machines and an air compressor.

Some Improvement Seen

WHILE manufacturers of molding machines continue to find foundrymen in the Cleveland district reluctant to purchase any new equipment or to close on inquiries which have been hanging fire for some time, makers of ovens, sand conditioning equipment, sand-blast and dust-arrester equipment are finding greater activity in their respective lines. Some of the latter manufacturers are securing sufficient business to keep their plants running at a fairly good rate, and feel that the bottom has been passed in the foundry equipment market, better business being expected from this time. Considerable repair business is being done in this district, many plants that are practically down taking advantage of this period to bring their equipment into good shape.

The Standard Sand & Machine Co., Cleveland, has sold a core-sand mixer to the Kilby Mfg. Co., Cleveland, and a mixing and blending machine to the Link-Belt Co., Chicago. The latter equipment will be used as part of a sand handling unit being built by the Link-Belt Co. The W. W. Sly Mfg. Co., Cleveland, has sold several types of equipment, included among which are sand-blast rooms to the Crane Co., Chattanooga, Tenn., a tilted blast mill of the positive pressure type to the Jewell Steel & Malleable Co., San Francisco, tumbling mills to the Falkirk Iron Co., Ltd., Falkirk, Scotland, and spark arrester equipment to the Ford Motor

Co. of Canada, Ltd., Walkerville, Ont. The National Foundry Co., Erie, Pa., has purchased abrasive separator equipment from the Pangborn Corp., Hagerstown, Md.

Business Continues Slack

CHICAGO district manufacturers of foundry equipment have considerable inactive inquiry before them, but prospects of turning this into immediate business are no brighter. Gray iron and malleable foundries have been generous buyers of pig iron while malleable foundries have placed some scrap, but improvement of their operating facilities apparently awaits a decided upturn in orders for castings. A maker of patterns whose experience has been that increased demand for his product foreruns improved general business by 60 to 90 days is doing more business now than in many months. The National Engineering Co., Chicago, has placed one of its sand mixers in the foundry of the Elliot Mfg. Co., Jeanette, Pa. The Simms Foundry Corp., Racine, Wis., is in the market for several square tumbling barrels. The Pangborn Corp., Hagerstown, Md., has sold dust arrester equipment to the Mueller Mfg. Co., Decatur, Ill., and the Packard Motor Car Co., Detroit, and a sand-blast cabinet to the Holley Carburetor Co., Detroit. Tumbling mill installations have been sold by the W. W. Sly Mfg. Co., Cleveland, to the Ford Motor Co., Highland Park, Mich., the Gleason Mfg. Co., Port Washington, Wis., and the Michigan Motor Casting Co. of the Buick Motor Co., Flint, Mich. The same manufacturer sold a blast pressure tank to the Wm. E. Pratt Mfg. Co., Joliet, Ill., dust arrester equipment to the Cadillac Motor Car Co., Detroit, and the East St. Louis Castings Co., East St. Louis, Ill.

East Closes Few Orders

LISTLESSNESS still dominates the eastern foundry equipment market. While some of the specialty foundries are fairly active, there appears little doubt but what the industry as a whole in this district is operating around the lowest point this year. With this condition prevailing and with little prospect of a material improvement, much before September, and the outlook then none too certain for a while, buyers are not closing on much new equipment. This situation has served, further to check work on contemplated extensions and new projects. At the moment, in fact, there appears to be no new important foundry construction being started.

Although list prices on the general run of equipment are unchanged, sharp competition is forcing concessions in a number of instances. On electric overhead cranes, prices of under 9 cents a pound have been offered recently in some cases. It is unquestionably a buyers' market.

The Morris Machine Works, Baldwinville, New York, has purchased a sand-blast installation with dust arrester equipment from the Pangborn Corp., Hagerstown, Md., while the Philadelphia Rapid Transit Co., Philadelphia, has secured a sand blast cabinet and dust arrester equipment from the same manufacturer. The W. W. Sly Mfg. Co., Cleveland, has sold tumbling mills to the Poughkeepsie Foundry & Machine Co., Poughkeepsie, N. Y. and the Harrison Radiator Corp., Lockport, N. Y.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Draper Corp., Hopedale, Mass., is receiving bids for a boiler house, air compressor room, etc.

Atlanta Foundry & Machine Co., Atlanta, Ga., is constructing a 100 x 200-foot addition to its plant.

Smith & Winchester Mfg. Co., South Windham, Conn., has awarded the Aberthaw Co. a contract for constructing a foundry addition.

United Iron Works, Springfield, Mo., was damaged by fire recently with most of its loss confined to its molding department.

Contracts have been awarded for constructing a foundry for the state penitentiary, at Baltimore, costing approximately $85,000. C. B. Sweezey is warden. *Noted Jan.* 15.

Modern Brass Foundry & Mfg. Co., Columbus, O., has been incorporated for $50,000 by Leo Gleich, Leo O'Connor, Cecelia Gleich, Clarence H. Gleich and Edward Miller.

Simms Foundry Corp., 930 Tenth avenue Racine, Wis., is in the market for several square tumbling mills. M. S. Eldred is purchasing agent.

J. B. Miller Keyless Lock Co., Kent, O., manufacturer of locks and operator of a brass foundry, has applied for the use of city property upon which to construct a plant addition.

The National Furnace & Foundry Co., Beaverton, Ont., plans removing its plant to Oshawa, Ont., and is seeking a site in the latter city.

Anton Boarder, Cleveland, has purchased the interest of J. F. Blais in the Lay-Val foundry at Orrville, O., and the company hereafter will be known as the Orrville Brass Foundry Co.

National Malleable Castings Co., 546 North Homes avenue, Indianapolis, has plans for constructing a plant, 93 x 630 feet, of steel and concrete.

Third Mississippi river commission, Vicksburg, Miss., will erect temporary machine shops to replace structures recently burned. Major R. P. Howell is in charge.

The Columbus Iron Works Co., Columbus, Ga., operator of gray iron, brass and aluminum foundries, was damaged by fire recently with most of the damage being confined to the boiler room and power house.

The Healy-Ruff Co., Plymouth building, St. Paul, manufacturer of radiator apparatus, has plans for constructing a 1-story foundry at Walter and Water streets, to be used for gray iron castings.

Trenton Malleable Iron Co., Trenton, N. J., operator of gray iron, malleable, brass and aluminum foundries, has awarded the general contract to Joseph D. Drugan, for a 1-story, 70 x 120-foot plant addition.

American Seeding Machine Co., Springfield, O., is constructing an addition to its foundry. A 2-story brick building is being built for core oven purposes. The company operates gray iron, brass and aluminum foundries.

The Electric Steel Foundry Co., Twenty-ourth and York streets, Portland, Oreg., will construct a 1-story, 50 x 160-foot foundry for which it will purchase electric furnaces, cranes, ladles, etc.

Carolina Foundry Co., Baltimore, has acquired property in the rear of its plant for a plant for sand and core bins, handling equipment, etc. Richard B. Sparks, 723 South Carolina street, is interested.

Thatcher Furnace Co., 36 St. Francis street, Newark, N. J., manufacturer of furnaces, was damaged recently by fire with heavy loss. No plans for reconstruction have as yet been announced. The company operates gray iron foundries.

William F. Hartig Plow Co., Evansville, Ind., is constructing some buildings for foundry purposes. The Hartig company sold its present plant to the Inglehart Milling Co. A. W. Hartig is president of the company of that name.

Builders Iron Works, Montreal, Que., has been incorporated with $15,000 capital, to conduct business of iron foundry, mechanical engineer, and builder of machinery. Francis C. E. Burnett, Perry P. Crampton and John Harper are incorporators.

Continental Gin Co., Avondale, Ala., has started construction on a 135 x 400-foot foundry and a 150 x 300-foot machine shop. L. R. Munger, Title Guarantee building, Dallas, Tex., is president of the company. H. K. Ferguson Co., Cleveland, is engineer and architect.

Nanticoke Sash Weight Co., Nanticoke, Pa., recently incorporated for $5000, has taken over the plant of the Nanticoke Foundry Co., where it will produce sashweights and conduct a general foundry business. J. W. Kirby is president, J. F. Kirby, vice president and K. F. Kirby, secretary. *Noted July* 15.

The Stoughton Wagon Co., Stoughton, Wis., manufacturer of motor trucks, busses, and similar vehicles and operator of a gray iron foundry, is making extensive alterations to its

plants. General truck capacity will be increased from 50 to 75 per cent and equipment installed so that the company can build its own gas engines.

W. S. Tyler Co., 3618 St. Clair avenue, Cleveland, has let general contract to Sam W. Emerson Co., 508 Union building, that city, for a 2-story, 110 x 110-foot brick and reinforced concrete plant. The company operates gray iron, brass and aluminum foundries and manufactures wire cloth, etc. Christ Zimmerman is secretary.

Frank M. Davis and John Thompson, Milwaukee, manufacturers of continuous milling machines and other equipment have incorporated as Davis & Thompson Co., with $200,000 capital. Davis and Thompson formerly manufactured gas engines but in 1918 sold their plant at Fifty-seventh avenue and Mitchell street, to the Avery Co., Peoria, Ill., now defunct. The shop at 251 Reed street, Milwaukee, has been supplemented by use of part of the Avery works, which contain a gray iron foundry and large machine shops.

New Trade Publications

WRENCHES—The various features of a special wrench are described in a bulletin issued by the Speednut Wrench Corp. Chicago.

PORTABLE LOADERS—Various types of industrial portable loaders are described and illustrated in a 40-page booklet issued by the Link-Belt Co., Chicago. Specifications of the various types shown are given.

CRANES—The Link-Belt Co., Chicago, recently has published a 40-page booklet on locomotive cranes. The various types are illustrated as are the feature parts of the cranes. A gondola car dumper also is described.

FANS—In two bulletins the American Blower Co., Detroit, describes its disc and multiblade fans in various forms and sizes for a wide range of uses. Data by which to determine the proper type and size are also given.

INSURANCE—In a book entitled "When Insurance Insures and When It Doesn't," the American Appraisal Co., New York, presents information on the proper methods of estimating the value of industrial property for insurance purposes.

FLEXIBLE SHAFTS—Flexible shaft equipment for grinding, polishing, buffing, scratch brushing, rotary filing, sanding, drilling, reaming, tapping, etc. is described and illustrated in a 32-page booklet recently issued by N. A. Strand & Co., Chicago.

LEATHER PACKING—Proper packings for machinery to insure efficient operation is insisted on in a catalogue by the Charles W. Marsh Co., Muskegon, Mich., which covers the molded leather packings produced by that company for a wide variety of uses.

UNIT HEATERS—Analysis of the situation in the unit heater field and information on the type of radiation for various conditions are included in a bulletin by the Buffalo Forge Co., Buffalo, N. Y. Illustrations include halftones and drawings of installations and designs and details of construction.

TANKS—Steel and wooden tanks for varied industrial purposes are described and illustrated in a catalog distributed by the W. E. Caldwell Co., Louisville, Ky. Much information as to the proper tank for various purposes and a large line of accessories to make the tanks more useful are included.

ELECTRIC GRINDERS—Electric machines for grinding, buffing and polishing are described and illustrated in a pamphlet issued by the Cleveland Armature Works, Inc., Cleveland. The various features of the machines are shown on sectional drawings while views are shown of actual installations.

EXHAUST FANS—Exhaust fans for use as part of ventilating systems are described in a folder recently issued by the Northern Blower Co., Cleveland. General data are given on the fans and the various parts are illustrated and described. A view of the fan system installed in a plant also is given.

STEEL TANKS—Containers for storing liquids under or above grounds, as manufactured by the Sisterville Tank & Boiler Works, Sisterville, W. Va., are described in two loose-leaf circulars which will be followed by others to serve as reference to tank users. Specifications of various sizes guide to the choice of tanks.

LADLES—The Whiting Corp., Harvey, Ill., has issued a 32-page booklet describing their line of ladles. Features of special ladles are described, such as the tilting mechanism which is mounted on the trunnion, crane ladles, crane truck ladles, slag truck ladles, bottom tap ladles, teapot spout ladles, trolley ladles, car wheel ladles, etc.

SPEED REDUCERS—Foote Bros. Gear & Machine Co., Chicago, has issued a catalogue of spur-gear and worm-gear reducers used to obtain relatively slow motion from a high-speed motor. Ratios from 7 to 1 up to 100 to 1 are provided. The construction is described and installations for various purposes are illustrated.

REFRACTORY MATERIALS—The Quigley Furnace Specialties Co., Inc., New York, has issued a bulletin describing a number of successful applications of a refractory material for bonding fire brick and for kindred uses. The use of crushed old fire brick for patching and rebuilding furnace walls is described and illustrated with correct mixtures included.

INDUSTRIAL FURNACE STOKERS—Application of mechanical stokers to heating furnaces in the industry is the subject of a catalog by the Sanford Riley Stoker Co., Worcester, Mass. Advantages claimed for stoker firing compared with hand stoking are included. Details of the construction and operation of the stoker are presented with comparisons of the cost of coal and oil.

COOLING FANS—Giving relief to men whose duties require them to be close to high temperatures is the subject of a bulletin issued by the American Blower Co., Detroit. Portable fans of large size with heavy motors, portable as a desk fan, provide a strong blast that covers a wide area and relieves workers from the effects of great heat, increasing their effectiveness.

POWER PLANT EQUIPMENT—The Swartwout Co., Cleveland, has issued a 56-page booklet giving information on steam traps, steam and oil separators, feed water heaters, cast iron exhaust heads, air separators, sediment traps and strainers and water level control valves. Dimensions of the various parts described are given and sectional sketches of the parts are included.

SAWS—Solid and inserted tooth metal cutting circular saws manufactured by the Hunter Saw & Machine Co., Pittsburgh, are covered in a catalogue by that company. Design, material, heat treatment and workmanship are discussed and much information is furnished as to the proper method of ordering for special purposes. Accessories necessary for conditioning saws for efficient work are also featured.

HEAT TREATMENT—Electric furnaces and pyrometers for accurate control of heat treatment of steel parts are described in a catalog giving the principles and practice of heat treatment, issued by the Leeds & Northrup Co., Philadelphia. The theory of controlling the physical structure of steel by heat treatment and the use of the thermocouple are discussed thoroughly and installations of the company's equipment are shown.

SAND THROWING MACHINE—The Beardsley & Piper Co., Chicago, has issued a 40-page booklet on a sand throwing molding machine. The various molding operations which each type of sand throwing machine will perform are given and the types of machines are described. The booklet is well illustrated with views of the machines in operation and with sectional drawings of the machines.

PULVERIZED COAL—The Holbeck Engineering Co., Cleveland, recently has issued a 20-page booklet on "Pulverized Coal Applied to the Malleable Iron Industry." The many advantages to be had in employing this type of fuel are listed. Views of various parts of the equipment necessary for burning powdered fuel are given as well as a sectional view of the entire system. Reproductions of photographs show a number of plants now using this type of fuel.

AIR FILTERS—Filtering air supplied to compressors and internal combustion engines is the aim of filters manufactured by Midwest Air Filters, Inc., New York, and described in a catalog being sent the trade. A cell acting as a multiple baffle, to which is added the effect of viscous-coated surfaces, removes particles in the air. Construction of the unit, installation and computations to determine the size necessary for various uses are fully treated.

VENTILATORS—"The Gospel of Fresh Air" is the title of a 36-page booklet which has been issued by the Swartwout Co., Cleveland. Methods of obtaining proper ventilation are discussed and the construction of the ventilator manufactured by the Swartwout company is described. Views are shown of the ventilator installed on public buildings, foundries, heat treating and drop forging plants, boiler rooms, engine rooms, machine shops, etc. Specifications for and methods of testing ventilators also are given.

THERMOELECTRIC PYROMETERS—Use of pyrometers now is so general in plants utilizing furnaces and kilns that a booklet giving instructions for the installation and care of such apparatus has been issued by the Brown Instrument Co., Philadelphia. Improper installation and maintenance negatives perfect design and construction in many cases and comprehensive data to guide in caring for pyrometers is offered in this handbook. Theory and practice are reviewed and methods of checking and finding trouble are explained fully.

TRAMRAILS—An exceptionally complete treatise on electric tramrails is contained in a catalog recently published by the Cleveland Crane & Engineering Co., Wickliffe, O. Installations in various types of industrial plants and warehouses are shown including a number of views of the system in use in foundries. The various types of carriers and rails are described and specifications are given. Considerable information is given on tramrail switches, cross overs, fittings for rails, etc. The book contains a large number of illustrations and should be of value to any person interested in the subject of tramrails.